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Firms in competitive markets

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Chapter 1

Introduction

This thesis presents some of the research results I have derived during the last years as PhD student at the University of Vienna, research assistant at the London School of Economics and consultant at the World Bank in Washington DC. The selected articles all consider various empirical and theoretical scenarios in which firms face strategic decisions in competitive markets, and analyze their behavior. Together these chapters analyze several challenges for firms in a globalizing world, and consider aspects like the export survival probability of African firms, the threat to existing firms as exporters from other countries enter the market, the innovation and advertising decision of firms, and how it is related to competition. All these articles are unified by the common interest of how firms react to changing circumstances.

The first chapter analyzes firm behavior with respect to advertising. Using a policy change concerning the taxation of advertising in Austria in 2000 as a natural experiment, I am able to show how advertising expenditures and consumer prices react to changes of marginal advertising costs. I give evidence of informative and persuasive forces connected to advertising. A key result is that advertising increases consumer prices in some industries, and decreases them in others. In the framework of a search model I interpret advertising that decreases prices as informative, and advertising that increases prices as persuasive. In a pooled regression across all industries, informative forces seem to dominate. Thus my conclusion leads to policy advice against a general taxation of advertising, like in the case analyzed. However, since industries exhibit a heterogeneous response, this conclusion does not hold for all, and a taxation of advertising in industries where persuasive forces dominate may be desirable.

In a second article I derive a simple model of competition and advertising, which can also be interpreted as a model of competition and innovation. On the basis of a Dixit Stiglitz type model, this new model can explain why the relationship between competition and innovation is of an inverted-U type. At low levels of competition, the business stealing opportunity is too low to give good incentives for innovation, at high levels of competition the markups are too low to generate incentives for innovation. The resulting inverted-U shape of the relationship between competition and innovation holds on firm as well as on industry level. This model is consistent with certain empirical observations of recent

years that claim to have found such an inverted-U.

A third paper looks at the determinants of survival among African exporters, and highlights the importance of information and networks for the survival of African firms on export markets. This work relies on new data that gives detailed export information for African countries, and provides results from a survey among African exporters. This paper studies the survival rates of African exporters on various destination markets, and finds very high exit rates of African firms in all years. These exit rates are as important to long term sustained export flows as are entry of new firms. We find that more experienced or larger firms have better survival rates, and networks can play a crucial role to improve them. This article was co-authored with three researchers from the World Bank: Denisse Pierola, Leonardo Iacovone and Professor Olivier Cadot. I presented a version of this work at the Africa department of the World Bank in Washington DC, where it has helped to shape the policy to support African exports.

The final paper in this dissertation is empirically linked to the theoretical model in the second. Together with Leonardo Iacovone and Professor L. Alan Winters I studied the response of Mexican firms to the shock of Chinese exports. We document that firms respond by focusing on their core products conditional on survival, and that weaker firms exit from the markets when competition is harder. Further we show that the reaction to the competition shock is asymmetrical, such that larger firms are better equipped to face the challenge than smaller firms. These empirical observations link to recent developments in the theory of multi-product firms in trade, and generate key predictions. In addition, they give valuable quantifications to firms and policy makers that have come under pressure from Chinese competition. It will help the World Bank to address the often raised fear of China among developing countries in greater detail.

These works stress, that firms in competitive markets react quickly to changing circumstances – be it a competition shock, a fluctuating export markets environment, or a change of their costs due by policy – as predicted by theory. Firms are commonly found to behave as rational entities in a way consistent with rationality assumptions. Various policies are shown to effect firm behavior significantly, and results such as the focus on core products, innovation or advertising can be influenced effectively by policy makers.

Methodologically the empirical papers are related by the use of a differences in differences estimation strategy (with the absence of the Africa section), where the instruments applied are the shock of the change of the taxation of advertising, and the shock of Chinas entry to the world markets. While the datasets used come from various sources and different countries, they are largely firm level datasets from Mexico, Austria and four African countries.

Alongside the academic value of having quantifications of certain phenomena, and modified models to apply to certain scenarios, these articles also led to some real world policy conclusions, of which I will only stress key recommendations here, and provide more detailed conclusions in the corresponding chapters: (1) My investigation of the taxation of advertising has led me to conclude that this policy is across industries not beneficial for society. The main argument is that advertising seems to lower

prices by increasing competition through information on average. Hence a restriction of advertising increases prices. This is however not alike across industries, and advertising taxation in industries where persuasive forces dominate could be desirable. (2) My research on Africa has led to the observation that survival on export markets depends crucially on firm experience and networks. A country that wants to increase sustained export flows is thus advised to focus on key products close to its comparative advantage, as its exporters support rather than harm each other. (3) My investigation on the shock of China on existing exporters has shown that Chinas emergence on world markets has severe consequences for existing producers in Mexico. While it causes the exit and disappearance of weaker firms and products, it helps to focus the economy, and might bring with it an overall productivity increase.

All the mentioned co-authors have agreed to my use of the two co-authored articles for my thesis, and confirmed that my share of the work has been substantial for both. I have written both chapters myself, done all the regressions, and formulated the estimation strategies. I have helped to shape the questions and presented both works extensively at various conferences and seminars. I have written confirmation on that from all my coauthors, and can present these at request.

Special thanks is given to my advisors Maarten Janssen and Klaus Gugler and the external reviewer Peter Egger; to my coauthors for this work Leonardo Iacovone, L. Alan Winters, Olivier Cadot, Denisse Pierola; for helpful discussions especially to (in no particular order) Guy Michaels, Stephen Redding, Philippe Aghion, John Van Reenen, Gerhard Sorger, Mirco Draca, Holgar Breinlich, Caroline Freund, Aaditya Matoo, Emanuel Ornelas, Chad Syverson, Philipp Schmidt-Dengler; and for the provision of data to Statistic Austria, INEGI, Klaus Fessel from FOCUS, Judy Dean from USITC and PREM Trade at the World Bank. The Institute of Economics at the University of Vienna has supported me financially for the three years. According to the University regulation, a German abstract and a recent curriculum vitae are attached at the end of this work.

Chapter 2

Advertising expenditure and consumer prices

This chapter presents my best single-authored work, and I plan to use a version of this chapter as my job market paper. I have presented it widely at conferences and seminars.

2.1 Abstract

This paper estimates how advertising affects advertising expenditures of firms and consumer prices across all major industries. It makes use of a unique policy change in Austria in 2000 that caused a decrease of the taxation on advertising expenditures in parts of the country and a simultaneous increase in other parts. As demonstrated by a unifying model, persuasive forces cause advertising to increase consumer prices by shifting demand outwards, and informative forces to reduce prices by increasing competition. I find that advertising expenditures react immediate in the opposite direction of marginal costs of advertising, while the price reaction to advertising is negative in some industries (food, transportation, tourism) and positive in others (alcohol, tobacco, health, leisure, house and garden expenditures). Overall I find that a 9.5 percent increase of marginal costs of advertising results in a reduction by advertising expenditures by 17 percent and an increase of consumer prices by one percent.

2.2 Introduction

This work investigates how advertising costs affect advertising expenditures and consumer prices. It makes use of a policy change in Austria, which changed the marginal costs of advertising, and thus advertising expenditures. While previous works have estimated the impact of advertising on consumer prices for certain goods, this is to my knowledge the first study that investigates this question for

all major industries and an entire economy. As demonstrated below, advertising increases consumer prices in some industries, and decreases them in others.

There are at least three important reasons why advertising is of interest to economists: First, advertising has been debated at length in the theoretical economic literature of the last century. It is closely tied to the issues of information and search, which took a prominent place in economic theory in recent decades, but also features in models of entry barriers and product quality. Throughout its long debates advertising has remained a controversial topics, with contradicting policy recommendations (see below). Detailed empirical evidence might help to clarify this debate.

Second, advertising itself is an important business activity. In the United States media advertising accounts for almost 2 percent of GDP, while in Europe typically for about half that number. In the studied country Austria advertising accounted for a share of 0.009 of GDP in 2000.¹ Advertising is one of the main sources of revenues of the media industry, the internet but also cultural and sporting events. Evidence on the behavior of advertising can help the understanding and judgment of the future of these rapidly changing industries.

Third, the demonstration of the effects of a taxation of advertising, which this study provides, meets a recurring policy idea, of which I mention only a few examples: While there are many cities and towns worldwide that tax local advertising, there have been also frequent attempts to introduce an advertising tax on state or national level. In 1987 the Florida legislature enacted a sales tax on a range of services that included advertising. In a heavy storm of protests the advertising tax was attacked as “unfair, unwise and unconstitutional” (Hellerstein 1988), and repealed after only six months of installation. More recently in Pennsylvania in 2006 the senate discussed a bill (Senate Bill 854) that attempted to introduce a six percent sales tax on advertising in that state, but was not enacted (see Philadelphia Business Journal 2006). In Europe, the Slovak Republic charged a tax on all advertising expenditure which was eliminated when Slovakia entered the European Union in 2004. In 2008 the French president discussed the taxation of advertising revenues of private television stations.² Hence despite few actual observations of taxations of advertising on state or national level, it remains a recurring and important political subject, and an idea that is periodically discussed. A more common case is the ban of advertising for certain products like cigarettes or drugs, which are an extreme form of advertising restrictions.

For this investigation I make use of a policy change in Austria in 2000 that harmonized the regional taxation on advertising expenditure, thus simultaneously increasing it in some parts of the country while reducing it in others. A comparison of advertising expenditures of firms in these two parts shows a strong and sudden impact of the change in advertising costs on advertising expenditures across all industries. To investigate the change of consumer prices I complement this data on advertising expenditures with regional price indices, and show that also consumer prices were immediately affected,

¹The US data counts for the years 2001 to 2004 and was taken from Arkolakis (2008), while European numbers come from Kosmelj and Zabkar (2008).

²See the article *Sarkozy's vision of a 'BBC' for France* by Ben Hall in the Financial Times of January 8, 2008.

but differently across industries.

Throughout the debate advertising has remained a controversial topic: Some economists have argued that there are excessive amounts of advertising, which therefore may be a good target for taxation, while others suggested that underprovision of advertising calls for a subsidy.³ The main cause of this difference has been identified to be that advertising can be seen as *persuasive* or as *informative* (see Bagwell (2007)). Butters (1977) defines these two views as “advertising as a set of psychological ploys which induce consumers to buy products or brands that they otherwise would not buy”, or as “a provision of information which allows consumers to make more discriminating choices within the framework of a fixed set of preferences.” This distinction goes however, further back at least to the work of Alfred Marshall (1919), who defined similar categories by the names of combative and constructive advertising. The persuasive view of advertising typically sees changes in preferences, and consequently a decrease of elasticities of substitution between, and increased monopoly power of firms, and thus increasing market prices, while the informative view sees increased information for consumers, stronger competition and thus lower market prices.

An extreme example of a persuasive view was sketched by Pigou (1929), who wrote: “It may happen that the expenditures on advertisement made by competing monopolists simply neutralise one another, and leave the industrial position exactly as it would have been if neither had expended anything. For clearly, if each of two rivals makes equal efforts to attract the favor of the public away from the other, the total result is the same as it would have been if neither had made any effort.” This view might have been what Marshall had in mind when naming persuasive advertising ‘combative advertising’. Similar views on advertising have been expressed by Kaldor (1950), who asserts a harmful effect of advertising and advocates the introduction of a tax on advertising. Further, John Sutton (1974) makes the distinction between generated sales from advertising and diverting sales from advertising, where the described case would be encountered if there were only diverted and no generated sales. Finally, Gasmi et al. (1992) suggest that the advertising game between Pepsi and Coca Cola is a predatory competition that hardly serves to generate sales.

On the other hand, advertising might serve as a transporter of information. This idea has been formalized in models closely linked to the large literature on consumer search, but rather than the consumers searching the firms, the firms search for consumers via advertising. Here advertising provides useful information to the consumers such as the existence, the quality or the price of a good, see for example Butters (1977), Stahl (1989) or Grossman and Shapiro (1984). In these models advertising expenditure has a marginal effect on firm demand that will correspond to the marginal advertising cost it faces. Therefore a change of the cost function will likely change advertising expenditure, and thus demand. It follows that in these models the taxation of advertising has in general a clear effect on firm variables. More advertising increases competition and thus lowers prices. As demonstrated by

³Some examples of viewpoints among many others: Pigou suggested a tax on advertising in 1929, in addition Dixit and Norman (1978) have argued for the possible presence of excessive amounts of advertising. More recently Haan and Moraga-Gonzales (2008) argued that collusion with less advertising would benefit firms; Stivers and Tremblay (2005) present the case for a subsidy. Meurer and Stahl (1994) or Stegeman (1991) present a model that can have both effects as outcome.

Stahl (1989), in these models a subsidy for advertising might be desirable.⁴ A model of this class is provided below.

In this article I show that both these effects are present in some industries to a varying degree. This variation may help to distinguish different working mechanisms of advertising.⁵

In the theoretical part of this paper a model is presented, in which an informative element of advertising might serve to increase competition and thus reduce prices, while simultaneously a persuasive element shifts the demand curve outwards and thus might increase prices. If both elements are present in a single model the effect of a cost reduction of advertising on consumer prices is not clear, and depends on which effect dominates. This model can explain why prices increase in one, decrease in another and remain unaffected in a third class of industries if marginal advertising costs are shifted.

This paper proceeds as follows: section 2.3 presents a model that incorporates both: informative and persuasive views on advertising. Section 2.4 describes the data and empirical strategy used to estimate the effects of a change in marginal advertising costs on advertising expenditures and consumer prices, section 2.5 presents the results and section 2.6 concludes.

2.3 A model of informative and persuasive advertising

Since this paper analyzes how persuasive and informative forces of advertising differ across industries, I develop a model that contains both: An informative element of advertising that enables consumers to make better decisions, and a persuasive element that convinces consumers to change their preferences for certain goods. To achieve this, I take a standard model of informative advertising (in the line of Butters (1972) and Stahl (1994)) and extend it by a persuasive element. These models focus on the informative element of advertising, and have received some criticism through the observation that in practice advertising contains not solely information. If a persuasive element is added to the model this criticism does not remain valid.⁶

In principle I could have built upon another important and interesting class of models of advertising, which is based on the view that advertising expenditure itself may serve as a quality signal. This idea was developed by Nelson (1970, 1974, 1978) and later formalized by Kihlstrom and Riordan (1984) and Milgrom and Roberts (1986). In these models advertising expenditure can serve as a signal for quality, since it is more costly for low quality firms than high quality firms to advertise. By this view the content or form of advertising is irrelevant, Milgrom and Roberts write: “this type of advertising corresponds to a public burning of money”. This type of model invalidates one of the key findings of this paper,

⁴Grossman and Shapiro (1984) argue however that in the case of differentiated products advertising can lead to an inflation of the number of firms, which would not suggest the case for subsidy.

⁵Akerberg (2001) argues that advertising that provides product information can be distinguished, as it should only attract consumers that are inexperienced with the brand. This is however a different definition of price advertising used in the model here, since it also impacts experienced consumers.

⁶For empirical evidence on the amount of information in advertising see Anderson and Renault (2006), Abernethy and Butler (1992), Abernethy and Franke (1996).

the finding that marginal advertising costs influence advertising expenditures. If advertising really is a public burning of money, the optimal amount of advertising expenditure would remain the same if as a consequence of a tax part of the money is submitted to the government rather than to the flames, as long as the public is aware of that tax. Given that I find a strong reaction of advertising expenditures to advertising costs (see below), I chose against this class of models. There are other models that incorporate spatial dimension (Bester and Petrakis (1995)), which I think to be more relevant for investigations of local advertising, and models that analyze the content of advertising (Anderson and Renault (2006)), which is perhaps more useful for empirical studies of industry segments. Finally, models exist in which advertising serves as an artificial market entry barrier (Bain 1968, Schmalensee (1974), Cubbin 1981). The model presented here may be interpreted to have such a component as well.

Consider a market with $n \geq 2$ firms that produce a good that for the same level of advertising is a perfect substitute with production costs equal to zero. Firms compete by simultaneously choosing prices p_i and advertising expenditures a_i for firm i , taking the behavior from the other firms as given. The measure of advertising expenditure a_i denotes the probability that a given consumer will receive an advertisement of firm i . Therefore by definition $0 \leq a_i \leq 1$. Firms do not know how many advertisements from competitors a consumer has received, thus each consumer has the same probability to receive an advertisement from firm i . The costs of advertising level a_i are given by the cost function $c(a_i)$, which is assumed to be positive for all values $a_i > 0$ and monotonically increasing in a_i . Further I assume that $\lim_{a \rightarrow 0} c'(a) = 0$ and $\lim_{a \rightarrow 1} c'(a) = \infty$ to insure uniqueness. This assumption requires that it is nearly costless to inform a very small number of consumers, but very costly to reach every single consumer with advertising.

On the demand side of the market, there is a mass of consumers who wish to purchase one unit of the good at most. The mass of consumers is normalized to one without loss of generality. Consumers receive advertisements from firms, which indicate the price at which the advertising firm sells the product. A consumer who does not receive an advertisement does not buy the product, consumers who receive more or equal to one advertisement buy at the lowest price they observe, given this price is below their marginal willingness to pay. This is the information component of advertising, as developed by Butters (1977).

To introduce the persuasive element of advertising I built upon the work of Stigler and Becker (1977), who propose to model persuasive advertising by making a distinction between the price as firms see it and the price as it appears to households.⁷ If firm i charges price p_i for the good and advertises with advertising intensity a_i , consumers will respond to this price subjectively as if it was $\rho_i = p_i/g(a_i)$, where ρ_i is the subjective price as it appears to the household in question and $g(a_i)$ is a monotonically increasing function of the advertising intensity of firm i . The function $g(a)$ maps non-negative advertising expenditures into linear transformations of prices. Further I assume that the first derivative $g'(a)$ is strictly greater than zero, such that an increase of advertising expenditure makes

⁷Among others, also in Becker and Murphy (1993) argue that persuasive advertising may serve to shift demand.

the subjective price to appear smaller to the persuaded consumers. Thus advertising makes consumers more willing to buy the product at a certain prices.

It should be noted that in the model derived such an increase of $g(a_i)$ can be interpreted as a higher willingness to pay for the good by a given number of consumers, but also such that the number of potential consumers increases with an increase of a_i . In these models both these views are possible, since in practice a higher level of advertising for a given price leads to an increased demand for the advertised good.

The maximum willingness to pay for each consumer is assumed to be equal to a subjective price $\rho = v$. If a consumer receive no advertisement, or only advertisements suggesting prices $\rho > v$ she does not buy the product. If they receive at least one advertisement that suggests a subjective price ρ smaller or equal to v they buy from the firm with the lowest price.

A similar envelope theorem argument as developed by Stahl (1994) can be applied in the present case to show that in the situation analyzed in equilibrium the optimal advertising expenditure of a firm will be independent of the consumer price it charges.⁸ The convexity assumptions concerning costs ensure that for a firm a unique optimal level of advertising expenditure exists. This level is similar for all other firms, since they are ex ante identical. I will denote the constant equilibrium advertising expenditure of firms by a . Further, I will denote the equilibrium price distribution with $F(p)$, which indicates the probability that a firm charges a price lower than p .

The number of goods that firm i can expect to sell is in the case of two firms given by the demand function $D_i = a_i[1 - a + a(1 - F(p_i))]$, where in Nash equilibrium it must hold that $a_i = a$ (provided a unique solution for a exists). The terms of this demand function count the consumers that receive an advertising from firm i (by definition this is equal to a_i) and not from the rival $(1 - a)$ plus those consumers that receive an advertising from both firms provided that the price of firm i is lower. In the case of n firms this demand can be generalized and is characterized by the polynomial $D_i = a_i[1 - aF(p_i)]^{n-1}$. Then expected profits of firm i , denoted by $E(\Pi_i)$ are given by:

$$E[\Pi_i(p_i, a_i)] = a_i E([1 - aF(p_i)]^{n-1})p_i - c(a_i) \quad (2.1)$$

At any point of the equilibrium price distribution of consumer prices the expected profits must be the same. In equilibrium the upper bound of the price distribution is the marginal willingness to pay of consumers $vg(a)$ (see Varian 1980). The price distribution must be continuous since any breakpoint could be profitably undercut. At a price at the upper bound of the distribution the probability for another price to be lower $F(p)$ must be one. Expected equilibrium profits at this point can be derived straight forwardly and are given in equation 2.3.

The equilibrium price distribution $F(p)$ is then derived from equating the profit function of the upper

⁸In particular, if the profit function is expressed in terms of ρ instead of p , its form is a special case of the general form analyzed by Stahl. Some empirical evidence on this finding was presented by Caves and Greene (1999), who found that advertising does not serve as an indicator of quality.

bound with expected profits. Equating profits at the upper bound of the price distribution with expected profits while setting $F(p_i) = 0$ (since at the lower bound prices can't be undercut) yields the lower bound of the equilibrium price distribution. Thus the equilibrium price distribution is given by:

$$F(p) = \begin{cases} 1 & \text{if } p \geq vg(a) \\ \frac{1}{a} \left[1 - (1-a) \left(\frac{vg(a)}{p} \right)^{\frac{1}{n-1}} \right] & \text{if } (1-a)^{n-1}vg(a) < p < vg(a) \\ 0 & \text{if } p \leq (1-a)^{n-1}vg(a) \end{cases} \quad (2.2)$$

The expected equilibrium profits of each firm are:

$$\Pi_i = a_i(1-a)^{n-1}vg(a_i) - c(a_i), \quad (2.3)$$

Given symmetry, in equilibrium it holds that $a_i = a$, provided the solution to a is unique. The main adoption with respect to the model of Butters (1977) and Stahl (1994) (absent concrete demand assumptions I take) is the introduction of the persuasive element $vg(a)$. Thus also the results so far are largely similar; without the adjustment above equation would be similar except for the $vg(a)$ term. Equilibrium advertising expenditures as derived in equation 2.3 are indeed independent of consumer prices. The expected value of prices is given by:

$$E(p) = \frac{(1-a)vg(a)}{(n-2)a} (1 - (1-a)^{n-2}). \quad (2.4)$$

Consider the introduction of an advertising tax which transforms the cost function of firms from $c(a)$ to $c(a^t)(1+t)$, where a^t denotes advertising expenditures under taxation. The advertising tax considered in the empirical analysis in this paper works in a similar fashion, since it is calculated as a constant share of all advertising expenditure of a firm.

- *Proposition 1: In equilibrium $\partial a / \partial t < 0$. The introduction of a proportional tax on advertising expenditure decreases advertising expenditure. See appendix 1 for a proof.*

Proposition 1 holds in the extended model that includes the persuasive $g(a)$ term, but it is also observed in previous models that do not incorporate a persuasive element. A difference is observed when prices are considered:

- *Proposition 2: In equilibrium $\partial p / \partial a$ may be positive or negative depending on the parameters and the location on the price distribution. While the upper end of the price distribution increases with an increase of the equilibrium advertising expenditure a , the lower of the price distribution and the expected value of prices may increase or decrease.*

Proof: First consider the model that does not have the persuasive element represented by the $g(a)$ term. In this version the derivative of the price distribution with respect to a is given by:

$$\frac{\partial F(p)}{\partial a} = \frac{1}{a^2} \left[-1 + \left(\frac{v}{p} \right)^{\frac{1}{n-1}} \right].$$

Since in this model v is the maximum willingness to pay and hence the maximum observed consumer price it will hold that $p \leq v$. The derivative above must be greater or equal to zero. $F(p)$ denotes the probability to observe a price lower than p , hence if $F(p)$ increases for a given value of p , this suggests a decrease of prices. Higher advertising expenditures increase competition and thus decrease prices in this purely informational model. In the model extended by $g(a)$ however the partial derivative becomes:

$$\frac{\partial F(p)}{\partial a} = \frac{1}{a^2} \left[-1 + \left(\frac{vg(a)}{p} \right)^{\frac{1}{n-1}} \left[1 - \frac{a(1-a)}{n-1} \frac{g'(a)}{g(a)} \right] \right].$$

The term $(vg(a)/p)^{\frac{1}{n-1}}$ is greater or equal to one since $p \leq v(g(a))$, the term $[1 - a(1-a)g'(a)/[(n-1)g(a)]]$ is smaller than one since all the components of its second term are positive. Note that at the upper bound of the price distribution where $p = vg(a)$ this partial derivative is negative. Hence the upper bound of the price distribution increases with higher advertising expenditures for all parameters of the model. This is due to the persuasive element that advertising expenditures increase the maximum willingness to pay of consumers.

Prices at the lower bound of the price distribution, where $p = (1-a)^{n-1}vg(a)$ will increase if $(n-1)g(a) < g'(a)(1-a)$, and decrease or remain the same otherwise. Hence at the lower bound prices are more likely to decrease for a large number of firms n , or a small opportunity to persuade consumers (small $g'(a)$). In these markets the price distribution widens with advertising. Else markets are parametrically possible where all prices increase (in the sense that the values on the cumulative density function of prices becomes less or equal at all feasible prices).

From equation 2.4 follows that the expected value of prices will increase in the equilibrium advertising expenditure a if and only if:

$$a(1-a) \left[\frac{g'(a)}{g(a)} (1 - (1-a)^{n-2}) + (n-2)(1-a)^{n-3} \right] > 1 - (1-a)^{n-2}. \quad (2.5)$$

For a level of advertising expenditure close to zero this inequality will not hold, and an increase of advertising expenditure will decrease the expected value of prices. Note that even in the case of a large number of firms the expected value of prices may increase or decrease; given a large number of firms it will increase if

$$a(1-a)g'(a) > g(a). \quad (2.6)$$

This suggests that in markets with a large number of competitors and either very low or very high initial equilibrium levels of advertising an increase of advertising expenditures decreases consumer prices. At intermediate levels of advertising the $g(a)$ function determines if prices increase or decrease with advertising expenditures. If persuasion is strongly possible (represented by a large $g'(a)/g(a)$) prices are likely to increase with advertising expenditures. This provides another testable implication: Industries with a large ratio of $g'(a)/g(a)$ are expected to have more persuasive elements in their advertisings (since industries in which persuasion does not work focus on information), and also to have a stronger positive reaction of prices. Below I will show that such a relationship indeed exists in the data.

This model provides a unified framework to study both forces of advertising (information and persuasion) simultaneously at work. It yields the following testable predictions: (1) An increase of the marginal costs of advertising leads to a decrease of advertising expenditures. (2) Consumer prices may increase or decrease with advertising. (3) Industries where consumer prices increase with advertising are industries in which advertising has a large persuasive function. (4) Industries where consumer prices decrease with advertising are industries in which advertising serves to inform consumers. These predictions are tested in the next section.

2.4 Empirical strategy and data

This section describes first the estimation strategy, and after that the data used. The investigation relies on a policy change of the tax on advertising in Austria in 2000. Austria is one of the few countries in the world, and the only OECD country that collects a nationwide tax on advertising. The tax is officially called Werbeabgabe, and locally referred to as Werbesteuer. It covers advertising for goods and services from all industries. A constant fraction of all advertising expenditure (with few exceptions such as advertising expenditure for content in student run school magazines or the advertising of churches and benevolent non-profit organizations) has to be paid by the advertising firm to the government as advertising tax. This tax includes all television and radio spots, advertisements in newspapers and magazines, and expenditure for all other publicly displayed advertisements (see Grohall et al. (2007)).

The advertising tax was introduced in 1927, and remained in existence without breaks ever since. Until the year 2000 the tax on advertising was collected on a regional level, whereby the location reached by the medium and not of the advertising firm was determining the payable tax. There existed some differences among regions, most strikingly that the state of Tirol (one of the nine states that constitute the republic of Austria) did not collect such a tax. The amount payable in the other eight provinces was typically ten percent of advertising expenditure.⁹ Also, on the national level (on which the large

⁹The exceptions consisted of few municipalities who refunded parts of the tax to local advertisers in their area. The parliamentary committee debating the harmonization of the advertising tax thought the number of these municipalities to be negligible, and assumed a uniform tax of ten percent outside of Tirol in their debate (see Bundesgesetzblatt 2000).

majority of firms operate and most advertisements are made) the tax was ten percent.

After a change of the law, which took effect on June 1st 2000, the tax has been collected at the national level, with an overall tax of 5 percent (WKO 2002) for national, regional and local advertisers alike. Hence the year 2000 brought about an increase of the advertising tax on local advertisements from zero to five percent for local advertisers in the state of Tirol, while in the other states and for nation-wide advertisers the tax rate dropped from ten to five percent. For a more detailed legal description of the tax before and after the policy change see the legal description, Bundesgesetzblatt (2000). The map in Figure 2.1 shows a map of Austria and highlights the tax changes.

Two common sets of critiques of differences-in-differences estimates relate to possible endogeneity of selection of the treated group and the timing of the shock. First, since in the present case the policy was of a unifying nature, the difference between the treatment and control group emerge from the prior decision of Tirol not to install a tax on advertising. This difference, and thus the treatment group selection, dates back to the year 1927, when the state government of Tirol (represented by the governor Dr. Franz Stumpf) thought differently about the matter than the rest of the country. Between the years 1927 and 2000 the First Republic under which the law was established was replaced by a home made dictatorship, then under German rule, after which the country was occupied by the allies after whose return the current republic was installed. In addition the country experienced the great depression, the second world war, several changes of currency and the membership of the European Union. Hence there is reason to assume that the economic differences that influenced the political process asymmetrically then (such as for example a more influential lobby of the media) are not present in the same way today.

Secondly it may be argued that the control and treatment group in the presented experiment are not comparable, since they lived under different tax regimes prior to the policy change and might have selected themselves into the more suitable one. There are several answers to this: (a) the tax studied concerns a small fraction of firm expenditures. Advertising itself is for most industries not a major business activity, and the tax difference between Tirol and the other states itself concerns only a fraction of that fraction. Hence this factor is probably a minor consideration for many firms facing their location decision. (b) in the regressions concerning advertising expenditure the sample is restricted to businesses that advertise in one state only. Since Austrian states are small (the median populated state Tirol had less than 700.000 inhabitants in 2000) a regression that only involves local advertisers concerns for the most part small local businesses, whose location decision is mainly driven by the birthplace of its founder. (c) I provide a robustness check of within firm reallocation of advertising expenditures, which controls for firm differences. In this specification the treatment and control groups consist of the same firms, and thus do not allow for a selection bias. Further, Austrian states are small in the international comparison and less important policy makers than states in other countries. For example, the states do not collect income taxes and receive most of their budget and policies from the Austrian government to redistribute.

The timing of the policy would invalidate the estimation if it was chosen with considerations that favor one of the two groups, or if it was anticipated. The report of the finance committee of the Austrian

parliament, which drafted the law and suggested the change, lists the following reasons for its decision to harmonize the taxation of advertising across states (see Bundesgesetzblatt 2000): They refer to the lengthy debate about the usefulness of such a tax in the country, they list administrative complications for trans-state businesses due to the different tax regimes, and call for a general harmonization of taxes to avoid tax competition (although they do not see any signs of such a tax competition taking place, in fact there has been remarkably little adjustment). The minutes of the discussion of that parliamentary subgroup show that there was a less general, and quite particular cause for the timing of the initiative: A decision of the constitutional court of Austria from the year 1998 ruled that each local authority may only tax the advertising value generated on its territory. As apparent from the minutes, this decision made the collection of the tax in the case of some radio stations practically impossible. In turn parliament felt that the law had to be adjusted. None of these reasons suggests that the timing of the harmonization was chosen in a way that would benefit a particular state differently. Before the harmonization there was a recurring demand from the chamber of commerce to abolish the tax altogether, but no political party or representative took the matter into their program. Thus there was no reason to anticipate the harmonization for the year stated.

Another circumstance that would invalidate the natural experiment would be if Tirol was simultaneously effected by an important other shock that drives or biases the results. I check the archives of several national and international newspapers to see if Tirol was mentioned significantly more often in 2000 than in the other years of the sample. This is not the case, as highlighted for some newspapers in table 2.2. The *Economist* was chosen as an international newspaper that is likely to report important economic changes. Citations in the *New York Times* have been used in economic studies before to indicate importance of events (see Kuziemko, Werker (2006)). The *Wirtschaftsblatt* is the only Austrian daily that is primarily interested in economic matters, and *Die Zeit* is a German newspaper that reports frequently on Austrian events. Similar tables for the control group states are available on request, and do also not show an unusual frequency of mentioning of either state in the year 2000. Similarly, incomes were comparable between treatment and control group: with a GDP per capita of 26,300 Euro Tirol was the fourth richest state in Austria in 2000, a position it had in all prior years of the sample (ie. back to 1995).¹⁰ Estimations along the lines of equation 2.7 did not suggest that any state experienced a break in its time trend in 2000.

The data on advertising expenditures used comes from "FOCUS Research & Consulting Austria" (see Focus 2008). This company measures square centimeters and seconds of advertisements in TV and radio stations as well as newspapers and magazines. Using the advertising price lists of various medias, advertising expenditures of firms are estimated. The company supplied me with their complete dataset from 1995 to 2005, which records advertising expenditure per firm, year, medium and industry. Further they provided the area where the publication in question is available, and an industry classification for the advertising company.

This dataset does not include all publications available in Austria, but with over 400 news providers all major ones and a large range of small local magazines. Table 2.1 reports by state the number

¹⁰Source of regional GDP data: Statistik Austria online database.

of regional advertisements recorded, the number of regional mediums (typically local newspapers, here only shown if they are exclusive to one state), the log average cost of an advertisement and the number of firms advertising in each of these mediums. In total, the dataset contains about 700,000 advertisements for the period considered. Table 2.1 shows that in terms of firms per medium and average advertising expenditures the values for the treatment state Tirol do not differ widely from the other states. In terms of the number of advertisements and regional media the treatment state Tirol is at the top of the distribution. The relatively high number of regional media in Tirol in this sample is most likely due to geographical reasons. Since Tirol shares only a small fraction of its border with other Austrian states, other states have more trans-state advertisers.

One of the disadvantages of that data is that it contains little information on each of the advertising firms and hence does not allow to include many control variables. Further the restrictions of the available data lead me to analyze the effect on advertising expenditures and consumer prices in separate datasets, and not a unified two stage regression. In its broad collection of advertisings that include small local businesses from all kind of industries, comparable over a long period of time the FOCUS dataset is unique in Austria.

The analysis of consumer prices relies on a different dataset provided by the Austrian statistical office (Statistik Austria). They provide price indices for twelve different industries (classified by the COICOP system of classification) on state level. Figure 2.3 displays prices of goods for the main COICOP groups for Tirol and the mean price for that good for the other eight states in Austria, again with confidence intervals for these other states. Note that there is no state-level variation in the prices for communication, which consists of the prices for mailing services only, which is organized by the Austrian National Post and does not vary at state level. This category is excluded from the estimation. Typically I estimate a differences-in-differences equations of the following type:

$$y_{it} = Post_t\beta_1 + Tirol_i\beta_2 + Post_t * Tirol_i * \beta_3 + \epsilon_{it}. \quad (2.7)$$

In this equation, *Post* is a variable that takes a value of one for the year of 2003 and a value of zero in the year 1997, *Tirol* is a dummy variable that indicates the firms advertising in the state of Tirol, and the interaction *Post * Tirol* gives the differences-in-differences coefficient of interest. In the regressions robust standard errors are clustered by state. Although the used data is a panel with many time dimensions, I typically focus on the year three years before and the one three years after the treatment (the years 1997 and 2003) to avoid correlation of errors in the regression (see Bertrand et al. (2004)). Some robustness checks with more complete panels and other years are provided. This type of differences-in-differences estimation is more common in fields of economics that do not study industry behavior, but there is no reason why it should not be used in this context, and such applications have been suggested for example by Angrist and Pischke (2010)).

2.5 Results

Effect on advertising expenditures

First I analyze how the growth rate of advertising expenditures reacted to the introduction of the tax. Given that the treatment differs on state level, and the treatment group consists of advertisers in one state only, I only use local advertisers, ie. firms that advertise in one state only. Since most advertising in Austria is on national level or across more than one state, this restriction reduces the number of observations in the dataset to less than ten percent. Since I do not want the results to be driven by firm selection in the pre and post treatment period, I use only firms that have positive advertising expenditures in all the eleven years from 1995 to 2005. The resulting panel consists of 89 firms in the province of Tirol and 174 firms in the other provinces, and includes a complete panel of total advertising expenditure for each of these firms and each year.

In order to normalize advertising expenditures I compute the growth rates of advertising expenditure. Figure 2.2 shows the mean growth rates of advertising expenditure for the two subsamples of Tirol and other states, and the 95 percent confidence intervals of these mean growth rates. These have been estimated using information on the coefficients from a regression of advertising expenditure on year fixed effects using robust standard errors clustered by industry. Reported are these dummy coefficients and 95 percent confidence intervals. To limit the influence of outliers, the one percent highest and lowest growth rates have been excluded.

There is clearly a higher growth rate of advertising expenditures outside of Tirol in the year 2000, which is the year in which the tax was implemented. In all other years the mean growth rates of advertising expenditures are not significantly different at five percent level of significance (see table 2.3). Also a test of differences of mean growth rates suggests only significant differences in the year 2000 with a p-value of 0.018 in the two sided test and 0.009 in the one sided test, while in all other years where Tirol is the treatment state, the p-values of a simple test of differences of means are above 0.05 and also 0.1. The jump of growth rate in 2000 for states outside of Tirol is the largest change of growth rate visible in the graph, the second biggest change is visible in Tirol from 1996 to 1997 and is about half of that in magnitude. These results provide evidence that the change in advertising costs led to an immediate strong increase of advertising expenditures in the states where advertising became less costly.

As a placebo test to this simple difference of means, I replace the treatment state with each of the other eight states of Austria, and rerun the exercise for all these eight states and nine years. This placebo test could not be done for the state Burgenland, since it does not have a single firm that fulfills the selection criteria for this exercise. These p-values from a test for the difference of means are reported in table 2.3. Further I exclude Tirol in the control group of the placebo exercises. In the placebo table there is no difference significant at one percent level of significance, and four that are significant at five percent level: in the years of 1999, 2000, 2001 and 2001 in the states of Niedersterreich, Salzburg, Krnten and Vorarlberg respectively. The numbers of these significant differences both for one and five percent is similar to the expected value of the number of false positives that would be expected in a

similar exercise with random data.¹¹

Figure 2.2 suggests, that the difference of growth rates of advertising expenditures as received by the media between states is 25.5 percent. This difference is the largest mean difference between the two groups observed in all the data. If firm expenditures are estimated, this difference is less, since those firms that increased their expenditures also had to pay fewer taxes. If the 9.5 percent¹² tax difference is accounted for, a 9.5 percent cost difference resulted in a 16 percent difference of advertising expenditures. Thus on average the estimates suggest that a one percent increase of advertising costs results in a 1.7 percent reduction of advertising expenditure conditional on firms not exiting from the advertising markets. This is the estimate of the elasticity of advertising expenditures with respect to marginal advertising costs, under the assumption that the advertising tax does not involve fixed or marginal administrative costs.

One concern is that despite the selection of surviving firms only, they might be affected differently by the unequal exit of other firms. However, these results are robust qualitatively and quantitatively (again the only significant difference of mean growth rates is observed in the year 2000, and in the reduced panel it is 27 percent) when the sample is restricted to those industries in which I do not find significant evidence for increased exit of firms (as specified in table 2.5).

To see how the effect differs across industries I provide estimates from a differences-in-differences regression in table 2.4. I focus on the year three years before and the one three years after the treatment (the years 1997 and 2003) to avoid correlation of errors in the regression (see Bertrand et al. (2004)) and use only firms that are present with positive advertising expenditure in both these years. Further I use again only advertisers that advertise in a single state, to compare consistently small local firms.

The industry classification is taken from the advertising expenditure dataset and it contains the following industries (and abbreviations): audio, video and photography (audio), construction, services, trade, house and garden (house), automotive (autom.), textile and tourism. I only provide results for industries with at least 30 observations (N reports the number of observations, and N_{Tirol} the number of observations in Tirol). There is evidence for a significant reduction of advertising expenditures in Tirol for all industries except for services, sports, trade, and tourism, where the differential effect is not significantly different from zero. The overall mean effect is negative and strongly significantly different from zero.

Additional evidence comes from the analysis of within firm reallocation. This estimation strategy can provide robustness with respect to a possible selection effect, since in this specification the treatment and the control group consist of different expenditures of the same firms. In addition, this estimation provides typically more observations since most of the firms in Austria advertise in more than one state. For this exercise I keep again only firms that have positive advertising expenditures in both the years

¹¹In a game with an outcome of H with probability 0.05 and T otherwise the probability to have at least 4 H after 56 trials is more than thirty percent.

¹²Tirol experiences a five percent increase of costs from one to 1.05, and the other states a decrease of 4.5 percent from 1.1 to 1.05.

1997 and 2003 in Tirol and at least one other state. For each firm I aggregate all advertising in states outside of Tirol. Thus for the regression there remains a sample with four advertising expenditure observations per firm (within and outside of Tirol in the years 1997 and 2003). Using this sample I estimate in OLS a differences-in-differences regression using again robust standard errors. Firm fixed effects are applied in this exercise. The results are reported in the second part of table 2.4. Again I report all industries with more or equal to 30 observations, given the differences of samples, these industries differ from the ones reported previously. There is again strongly significant evidence for a reduction of advertising expenditures in Tirol within firms overall, and for all industries except tourism.

Taken together, these results suggest that the increase of advertising costs indeed led to a decrease of advertising expenditures across almost all industries, and to the opposite effect in no industry. Many of the views on advertising described in the literature section of this article would not predict such an adjustment of expenditures and can be ruled out as sole explanations for advertising.

Exit from advertising markets

In addition to the reduction of advertising expenditures, many firms may decide to stop advertising altogether as a consequence of the tax change, which is an extreme form of adjustment of advertising expenditures. Table 2.5 reports the estimates of differential exit by industry. In this probit regression all advertisers that advertise in one state only are used, regardless of the duration of their appearance. Because I do not restrict the sample to firms that advertise in all years, the number of observations is much larger than in the previous tables, and hence cover more industries. The time dimension of each firm is collapsed into two periods, one before the change (the years 1995-1999) and one after the change (2001-2005), hence for each firm I have a maximum of two time observations. Exit is a variable equal to one at time t if that firm advertises at time t but not at time $t + 1$.

There is evidence for more exit from advertising in Tirol (where the tax increased) in the following industries: audio, video and photography (audio), services, sports and leisure (sports), house and garden (house) and textile. Tourism is the only industry that shows a negative coefficient that is significant on 10 percent level of significance, however not on five percent level. In all other industries there is no evidence for a differential effect.

Hence there is evidence of moderate exit from advertising in some industries due to the increase in advertising tax, but for the majority of industries no such effect is found. The previous results on the reduction of advertising expenditures as a consequence of increased advertising costs are robust to the exclusion of the industries for which significant evidence for exit was found.

Prices

In the literature there exists some evidence of how advertising affects prices. In particular, several studies make use of bans of advertising in certain areas for particular goods. They found that advertising seems to decrease prices for eyeglasses (Kwoka 1984) children's breakfast cereal (Clark 2007) and drugs (Cody 1976) among others. Milyo and Waldfogel (1999) present evidence that suggests that advertising decreases the price of advertised goods in liquor stores, while it increases the price of

non advertised goods in the same stores. On the other hand, Gallet and Euzenet (2002) suggest that advertising to sales ratios have a positive effect on the supply price in the brewing industry.¹³

Following the previous strategy I use the difference between the years 1997 to 2003, but given that prices fluctuate more than advertising expenditures I provide also the difference for the years 2001 to 1999 and 2002 to 1998 (see table 2.6). The price indices are normalized such, that in the initial period they have a value of 1 for each category. Hence the the differences in differences coefficient can be interpreted as additional percentage increase over the period given. This method does not introduce the common problem of correlated errors in differences-in-differences estimations, but given nine states and two years it gives few observations (18 observations if the main groups are used). To increase the number of observations I use the most disaggregated level for which I can access price information (typically this is on COICOP three digit level). In these regressions I apply state fixed effects and cluster robust standard errors by state.

This table confirms what is observable in graph 2.3. Coefficients of the variable of interest, the differential effect measured by the coefficient on PT , have the same sign for all three specifications if they are significantly different from zero. The graph provides evidence for an overall increase of prices in Tirol measured on the most disaggregated level of information. There is further evidence that prices increased in the industries food, transportation, education and tourism while it decreased for alcohol and tobacco, health, leisure and house and garden.

As a further robustness check I rerun this estimation for the overall mean price, using COICOP one digit groups instead of the more fluctuating detailed groups taken before. See the results in table 2.7. Again these estimates suggest an increase of prices in Tirol. As a placebo exercise I rerun that same equation for the years 1993-1999 and 1992-1998 (these are the years for which I can built six year differences as above), and this effect is not visible.

Persuasive and informative advertising industries

The observed differences of the behavior of consumer prices across industries points to possible differences of the parameters across industries. Consumers may be easier persuaded in industries in which they base their buying decision on the advice of experts (health) than in industries in which they are well informed themselves through daily purchases (food). In an industry in which persuasion is not easily possible advertising content focuses on the informative aspect of advertising, while industries with persuasive potential will afford to put additional elements on their advertisings.

As discussed in the model section above, the model predicts a positive relationship between industries in which advertising leads to a price increase, and persuasive content of advertisings. To test this prediction I rely on a meta-analysis that provides the information share in advertisings from different industries (Abernethy and Franke (1996), table 2). In their article they summarize the findings from 60 studies that measure information content of advertising. Using the methodology developed by Resnik and Stern (1977), which relies on the count of well defined *information cues*, they give estimates of the information share across industries. I merge their industry with the COICOP industries from the

¹³In a related earlier study Gisser (1999) found no significant relationship in the same industry.

Statistic Austria where this was possible with confidence (see Appendix 2). Graph 2.4 shows a clear positive correlation between the price response I estimate in table 2.6 and the information content reported.

The correlation between the two series is greater than 80 percent, a regression with robust standard errors yields a slope that is significantly different from zero at five percent level of confidence. The slope coefficient of the displayed line is 0.0019 with a standard error of 0.00049 and a robust standard error of 0.00054.

Summary

The results show a significant relative reduction of advertising expenditures or a more frequent exit from advertising markets in the state of Tirol, which experienced a relative increase of the advertising tax overall and for the large majority of industries. Further the results highlights a within-firm reallocation of advertising expenditures out of Tirol. Thus while the advertising expenditures react consistently across industries, consumer prices increase for some and decrease for other industries. In particular, there is evidence that prices increased in the industries food, transportation, education and tourism while it decreased for alcohol and tobacco, health, leisure and house and garden.

To get a sense for the magnitude of the overall price change, I use the weights for each of the COICOP one digit groups provided by Statistics Austria (2010). The weighted differential growth rates from table 2.6 suggest that mean prices in Tirol were about 1 percent higher than in the other states after the introduction of the tax. This suggests that the 9.5 percent difference in marginal advertising costs, or the 25.5 percent difference of advertising expenditures arriving at media, or the 16 percent difference of firm expenditures on advertising resulted in a one percent difference of consumer prices. Note that this mean price consists of positive and negative growth rates. The effects for certain industries or products can be much higher or lower as apparent from table 2.6.

2.6 Conclusion

A policy which involved a change of the taxation of advertising is used to estimate across industries how advertising costs affect advertising expenditures and consumer prices. The data suggests that the proportional taxation of advertising expenditures is an effective policy to reduce advertising; I estimate that a 1 percent increase of the marginal tax of advertising decreases advertising expenditures by 1.7 percent, and there is significant evidence of reduction across all industries.

On the basis of a theoretical model I show that in principle prices may increase or decrease with advertising, depending on whether persuasive or informative forces dominate in an industry. The estimation results suggest that informative forces – such that advertising decreases prices – dominate in the industries involved with food, transportation, education and tourism; while persuasive forces seem to dominate in the industries of alcohol and tobacco, health and leisure and house and garden expenditures.

Thus there is a case to restrict advertising in these latter industries – and in fact many countries already restrict advertisements for alcohol, tobacco and health products. As shown, a proportional tax on advertising expenditures is a useful policy tool to achieve that goal. Overall however, the informative forces seem to dominate. I estimate that a ten percent increase of advertising tax leads to a one percent increase in consumer prices. Thus a complete abolishment of the five percent advertising tax would lead to an overall increase of competition and lower consumer prices by about half a percentage point. This effect however would differ across industries as described.

Appendix 1

Proof of proposition 1:

While for a single firm it is straight forward to show that given the advertising expenditures of its competitors an increase of advertising costs would decrease its advertising expenditures, this is less trivial for the equilibrium a in Nash equilibrium. Note first that if a solution to the optimal amount of advertising exists, it can't be the boundary solution of $a = 1$, since from equation 2.3 all firms would make losses at this level of a . Thus if an equilibrium solution with $a > 0$ exists, it must be an interior solution, and fulfill the following first and second order equilibrium conditions:

$$FOC = 0 \Leftrightarrow v(1-a)^{n-1}(ag(a))' = c'(a)(1+t)$$

$$SOC \leq 0 \Leftrightarrow v(1-a)^{n-1}(ag(a))'' \leq c''(a)(1+t)$$

The term $(1+t)$ on the right hand side denotes the tax on advertising. Let us consider the introduction of a marginal tax on advertising, an increase of t from 0 to ϵ . Rewriting the first order condition:

$$\frac{v(1-a^t)^{n-1}(a^t g(a^t))'}{c'(a^t)} = (1+t).$$

Before the introduction of the tax, the numerator and denominator on the left hand side have the same value. Proposition 1 states that a decrease of a would increase the left hand side to make the equation hold in the new equilibrium for an increased right hand side. To show is that in equilibrium the partial derivative of the left hand side of the equation above with respect to a is smaller than zero. This condition to be proven is:

$$\frac{[v(1-a^t)^{n-1}(a^t g(a^t))']' c'(a) - v(1-a^t)^{n-1}(a^t g(a^t))' c''(a)}{(c'(a))^2} < 0$$

From the first order condition, and given that we analyze the case where t is shifted from 0 to ϵ close to zero, follows that $c'(a) = v(1-a^t)^{n-1}(a^t g(a^t))'$ in the neighborhood of $t = 0$. This simplifies the condition above to:

$$(1-a)^{n-1}(ag(a))''v - (n-1)(1-a)^{n-2}(ag(a))'v < c''(a).$$

The term $(1-a)^{n-1}(ag(a))''v$ must be smaller or equal to $c''(a)$ by the second order condition. The term $-(n-1)(1-a)^{n-2}(ag(a))'v$ is less than zero, since all its components are positive. Thus the equation above must hold for all feasible equilibria, the left hand side decreases in a , thus a decrease in a is needed to balance the increase of taxes on the right hand side, and hence an increase of the marginal costs of advertising decreases the equilibrium advertising expenditure.

Appendix 2

The aim of this appendix is to show how the industries in COICOP classification from the Statistics Austria are linked with the industries from Abernethy and Franke (1996) (from here on abbreviated as AF). COICOP subgroup levels were matched with the most fitting industry, and then for each industry a weighted mean of information values was computed, the weights were taken from the baskets provided by Statistics Austria (2010). The categories of *food* and *alcohol and tobacco* were omitted, since they yield opposite price predictions, but are inseparably pooled in AF. For the table the estimates from the 1997-2003 differences in differences estimates were compared with the *percent informative* measures provided by AF in Table 2 on page 10.

The COICOP subgroups were merged as follows (the following paragraph shows in **bold** the main COICOP industry, in *italics* the COICOP two digit sub-industry, then in unformatted text the matched AF industry): **Health**: *Medical products and equipment*: Medicine, medical products; *Out-patient services*: Services; *Hospital services*: Personal care; **Clothing**: *Clothing*: Clothing; *Footwear*: Clothing; **Hotels, Restaurants**: *Catering services*: Financial, transportation, travel; *Accommodation services*: Financial, transportation, travel; **Transport**: *Purchase of vehicles*: Cars, *Operation of personal transport equipment*: Financial, transportation, travel, *Transport services*: Financial, transportation, travel; **House, water, electr., gas**: *Actual rentals for housing*: Laundry and household; *Maintenance and repair of the dwelling*: Laundry and household; *Water supply and miscellaneous services*: Services; *Electricity, gas, and other fuels*: Laundry and household; **Durable goods**: *Furniture and furnishing, carpets, floor coverings*: Furniture, home furnishes, appliances; *Household textiles*: Household, lawn, garden; *Household appliances*: Electronics; *Glassware, tableware, and household utensils*: Household, lawn, garden; *Tools and equipment for house and garden*: Furniture, home furnishes, appliances; *Goods and services for routine household maintenance*: Services **Recreation, culture**: *Audi visual processing equipment*: Hobbies, toy, transportation; *Other major durables*: Hobbies, toy, transportation; *Other recreational items and equipment*: Hobbies, toy, transportation; *Recreation and cultural services*: Services; *Newspapers books and stationary*: Toys, leisure, entertainment; *Package holidays*: Services; **Miscellaneous**: *Personal care*: Personal care; *Personal effects*: Hobbies, toy, transportation; *Social protection*: Institutional; *Insurance*: Financial, transportation, travel; *Financial services*: Financial, transportation, travel; *Other services*: Services **Food** Food.

Table 2.1: Descriptive statistics

	Number of advertisements	Number of publications	Log mean expenditure	Number of firms per publication
Burgenland	12,925	12	12.06	140.5
Krnten	30,467	15	12.4	275.4
Niedersterreich	34,678	19	12.54	250.3
Obersterreich	47,737	14	12.94	399.5
Salzburg	38,540	15	12.57	305.3
Steiermark	42,881	22	13.12	251.1
Tirol	58,501	22	12.36	298.4
Vorarlberg	24,886	11	12.58	270.2
Wien	27,049	18	13.49	186.9

Note: All columns consider only advertisements in publications that appear in no more than one state.

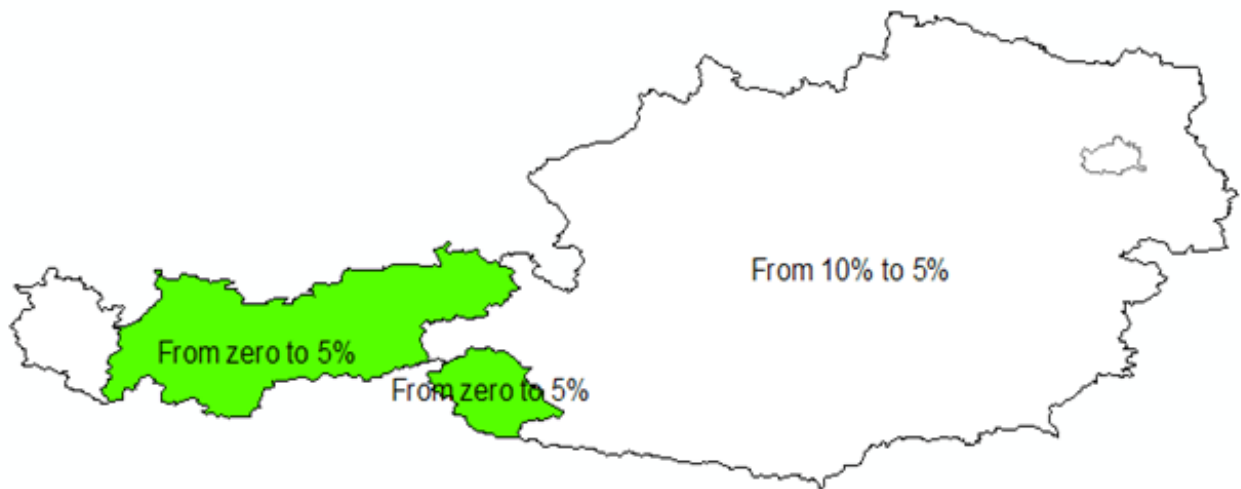


Figure 2.1: This map shows the heterogeneous changes of advertising taxes in Austria in 2000. The state of Tirol, which is highlighted in grey, experienced an increase in the marginal cost of State advertising, the other eight states of the country a decrease.

Table 2.2: Frequency of articles on Tirol in newspapers

Year	Economist	NYT	WB	Zeit
1996	n.a.	7	n.a.	21
1997	0	6	n.a.	20
1998	1	13	702	11
1999	0	11	748	26
2000	0	5	741	24
2001	1	8	776	27
2002	0	5	863	15
2003	0	5	795	22
2004	0	7	735	28

Note: This table shows how often the keyword “Tirol” was mentioned in the following newspapers: *The Economist*, *The New York Times*, *Wirtschaftsblatt* and *Die Zeit*.

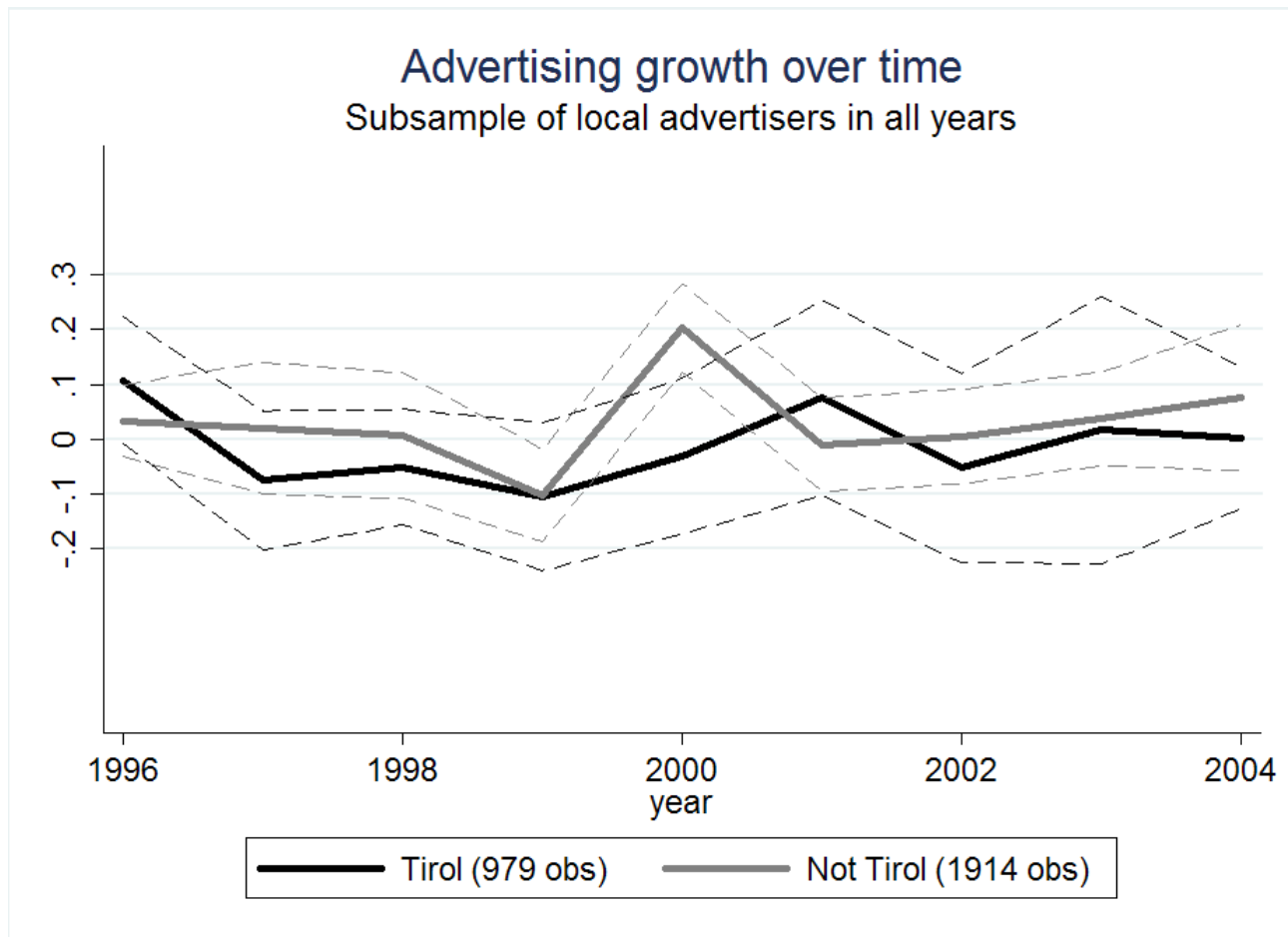


Figure 2.2: Growth rates of advertising expenditures inside and outside of Tirol for all Austrian advertising firms with positive advertising expenditures in all the years from 1997 to 2005. For the computation of the displayed 95 percent confidence intervals, advertising expenditure was regressed on time fixed effects. The one percent highest and lowest growth rates were excluded. Robust standard errors are clustered by industry.

Table 2.3: Differences of advertising expenditure growth rates

		Tirol		Wien	Salzburg	Lower A	Upper A	Styria	Carinthia	Vorarlberg
	Diff	Two s.	One s.	Two sided p-value						
1997	0.1	0.427	0.213	0.092	0.891	0.625	0.364	0.734	0.547	0.405
1998	0.08	0.505	0.253	0.863	0.363	0.122	0.936	0.299	0.133	0.933
1999	-0.02	0.894	0.553	0.817	0.616	0.028	0.825	0.105	0.601	0.947
2000	0.26	0.018	0.009	0.733	0.03	0.299	0.82	0.795	0.502	0.2
2001	-0.11	0.286	0.857	0.16	0.353	0.896	0.221	0.09	0.024	0.016
2002	0.03	0.778	0.389	0.68	0.288	0.656	0.432	0.39	0.191	0.867
2003	-0.04	0.754	0.623	0.868	0.275	0.382	0.966	0.438	0.462	0.947
2004	0.08	0.445	0.223	0.903	0.714	0.412	0.881	0.367	0.036	0.101

Note: P-values indicating the significance of the differences of means of the growth rates of advertising expenditures between the state indicated and the other states. For the state of Tirol in addition the size of the differences and the one sided p-values are reported.

Table 2.4: Differences in differences of advertising expenditures across industries

	All (1)	Audio (2)	Constr. (3)	Serv. (4)	Fin. (5)	Trade (6)	House (7)	Invest (8)	Autom. (9)	Pers. (10)	Text. (11)	Tour. (12)
Advertising expenditures - difference of regional advertisers												
Post	0.0740 (0.0683)	0.263 (0.286)	0.144 (0.202)	0.0731 (0.156)		-0.0513 (0.332)	0.0574 (0.0584)		0.281** (0.115)		-0.227 (0.170)	-0.0649 (0.198)
PT	-0.328*** (0.0691)	-0.650* (0.286)	-0.708** (0.202)	-0.259 (0.156)		-0.557 (0.332)	-0.232*** (0.0584)		-0.298** (0.115)		-0.498** (0.170)	0.139 (0.198)
N	1418	76	150	156		56	157		398		158	108
N Tirol	418	23	48	44		21	52		90		51	40
Advertising expenditures - within firm reallocation												
Post	1.328*** (0.104)	2.145*** (0.380)	0.645* (0.338)	1.672*** (0.245)	1.546*** (0.380)	1.250*** (0.441)	0.596 (0.384)	1.233* (0.650)	1.587*** (0.296)	1.144* (0.597)	0.862** (0.336)	0.221 (0.392)
PT	-2.146*** (0.107)	-2.301*** (0.405)	-1.565*** (0.330)	-2.610*** (0.253)	-2.603*** (0.338)	-2.294*** (0.496)	-1.709*** (0.377)	-1.821*** (0.548)	-2.455*** (0.245)	-1.960*** (0.512)	-1.967*** (0.376)	-0.596 (0.528)
N	960	60	112	158	58	58	82	44	92	32	64	36

Note: Both parts of the table report diff-in-diff estimates of advertising expenditures from 1997 to 2003. The first panel considers local advertisers; the second panel considers within firm reallocations for cross-state advertisers.

Table 2.5: Exit from advertising

	(1) All	(2) Other	(3) Audio	(4) Constr.	(5) Serv.	(6) Energy	(7) Food	(8) Finances	(9) Sports	(10) Drinks
Post	-0.233*** (0.0333)	-0.981* (0.508)	-0.000656 (0.170)	-0.289*** (0.102)	-0.191** (0.0831)	0.157 (0.397)	-0.456 (0.281)	0.420 (0.410)	-0.219 (0.226)	1.311 (0.952)
Post*Tirol	0.174** (0.0708)	-7.570 (1011)	0.689* (0.404)	-0.0411 (0.214)	0.385** (0.193)	0.173 (0.876)	-0.133 (0.666)	-0.0571 (1.080)	0.839** (0.400)	-2.226 (2.120)
Obs	16470	185	707	1492	3647	103	133	421	421	102
	(11) Trade	(12) House	(13) Invest	(14) Automotive	(15) Communic.	(16) Cosmetics	(17) Pers.	(18) Textile	(19) Touristic	(20) Media
Post	-0.416*** (0.154)	-0.226** (0.110)	-0.408 (0.275)	-0.129 (0.0845)	-0.179 (0.165)	-0.569* (0.301)	-0.212 (0.167)	-0.191 (0.139)	-0.426*** (0.0889)	0.0442 (0.228)
Post*Tirol	0.101 (0.297)	0.371* (0.217)	1.352* (0.760)	-0.0833 (0.212)	-0.144 (0.445)	0.148 (0.637)	0.0945 (0.378)	0.777*** (0.267)	-0.313* (0.177)	-0.298 (0.582)
Obs	862	1378	655	1884	493	159	361	1120	2083	255

Note: The table shows random effects probit estimation results of firm exit, which is a dummy variable that takes a value of one in the year in which a firms stops to advertise. Post is a variable equal to one after the treatment (the years 2001-2004) and equal to zero before (1995-1999). Industries with less then 30 observations are excluded from the table.

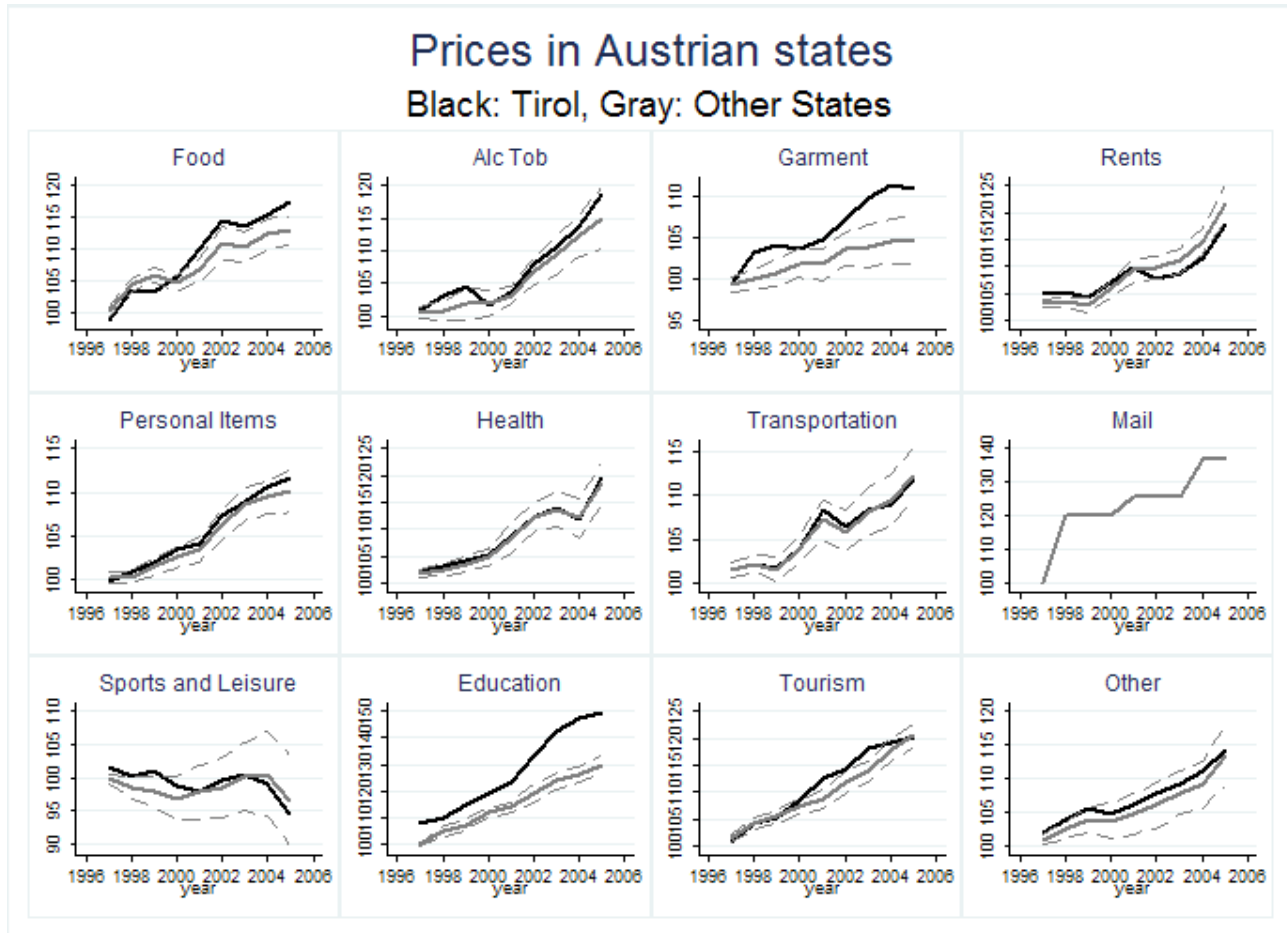


Figure 2.3: Prices

Note: State price index for Tirol by industries, and the mean price index of other states. Mail does not vary across states.

Table 2.6: Prices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(10)	(11)	(12)	(13)
	All	Food	Alc	Garment	House	Pers	Health	Transport	Leisure	Educ	Tour	Other
1999-2001												
Post	0.0291*** (0.00206)	0.00674 (0.00530)	0.0165** (0.00633)	0.0102 (0.00701)	0.0690*** (0.00884)	0.0186*** (0.00344)	0.0446*** (0.00136)	0.0555*** (0.00341)	-0.00565** (0.00235)	0.0613*** (0.0155)	0.0291*** (0.00428)	0.00714*** (0.00313)
PT	0.00664** (0.00206)	0.0605*** (0.00530)	-0.0226*** (0.00633)	-0.00406 (0.00701)	-0.00704 (0.00884)	0.00189 (0.00344)	-0.00354** (0.00136)	0.01000** (0.00341)	-0.0321*** (0.00235)	0.0127 (0.0155)	0.0405*** (0.00428)	-0.00279 (0.00313)
Obs	1,296	198	72	72	198	180	90	180	126	18	54	90
1998-2002												
Post	0.0557*** (0.00324)	0.0652*** (0.00522)	0.0602*** (0.00849)	0.0359*** (0.00700)	0.0604*** (0.00969)	0.0588*** (0.00588)	0.0955*** (0.00321)	0.0359*** (0.00412)	-0.00599 (0.00443)	0.421*** (0.0197)	0.0739*** (0.00443)	0.0345*** (0.00715)
PT	0.00368 (0.00324)	0.0438*** (0.00522)	-0.0119 (0.00849)	0.00440 (0.00700)	-0.0332*** (0.00969)	0.00450 (0.00588)	-0.00665* (0.00321)	0.00707 (0.00412)	-0.00523 (0.00443)	0.0570** (0.0197)	0.0245*** (0.00443)	0.000307 (0.00715)
Obs	1,296	198	72	72	198	180	90	180	126	18	54	90
1997-2003												
Post	0.0856*** (0.00303)	0.103*** (0.00490)	0.0889*** (0.0104)	0.0469*** (0.0103)	0.0789*** (0.0102)	0.0837*** (0.00903)	0.119*** (0.00581)	0.0675*** (0.00497)	0.000874 (0.00512)	0.539*** (0.0238)	0.122*** (0.00732)	0.0692*** (0.00714)
PT	0.00709** (0.00303)	0.0462*** (0.00490)	0.00633 (0.0104)	0.0569*** (0.0103)	-0.0399*** (0.0102)	0.00614 (0.00903)	-0.00265 (0.00581)	0.00204 (0.00497)	-0.0133** (0.00512)	0.0517* (0.0238)	0.0496*** (0.00732)	0.00254 (0.00714)
Obs	1,296	198	72	72	198	180	90	180	126	18	54	90

Note: The table shows OLS estimation results of prices at state level for all industries except mail services, which does not vary at state level. Robust standard errors are clustered by state.

Table 2.7: Prices, balanced panel and placebo exercise

	Balanced	Placebo	
	(1)	(2)	(3)
	1997-2003	1993-1999	1992-1998
Post*Treat	0.00994** (0.00298)	0.0102 (0.00711)	0.00781 (0.00618)
Treat	0.00204 (0.00147)	0.000382 (0.00626)	0.00181 (0.00546)
Const	4.655*** (0.00238)	4.791*** (0.00626)	4.750*** (0.00546)
Obs	774	774	774

Note: (1): estimation for the balanced panel of main COICOP subcategories only. (2) and (3): placebo exercises for the years 1992-1998 and 1997-1991. Robust standard errors are clustered by state, industry and year fixed effects applied.

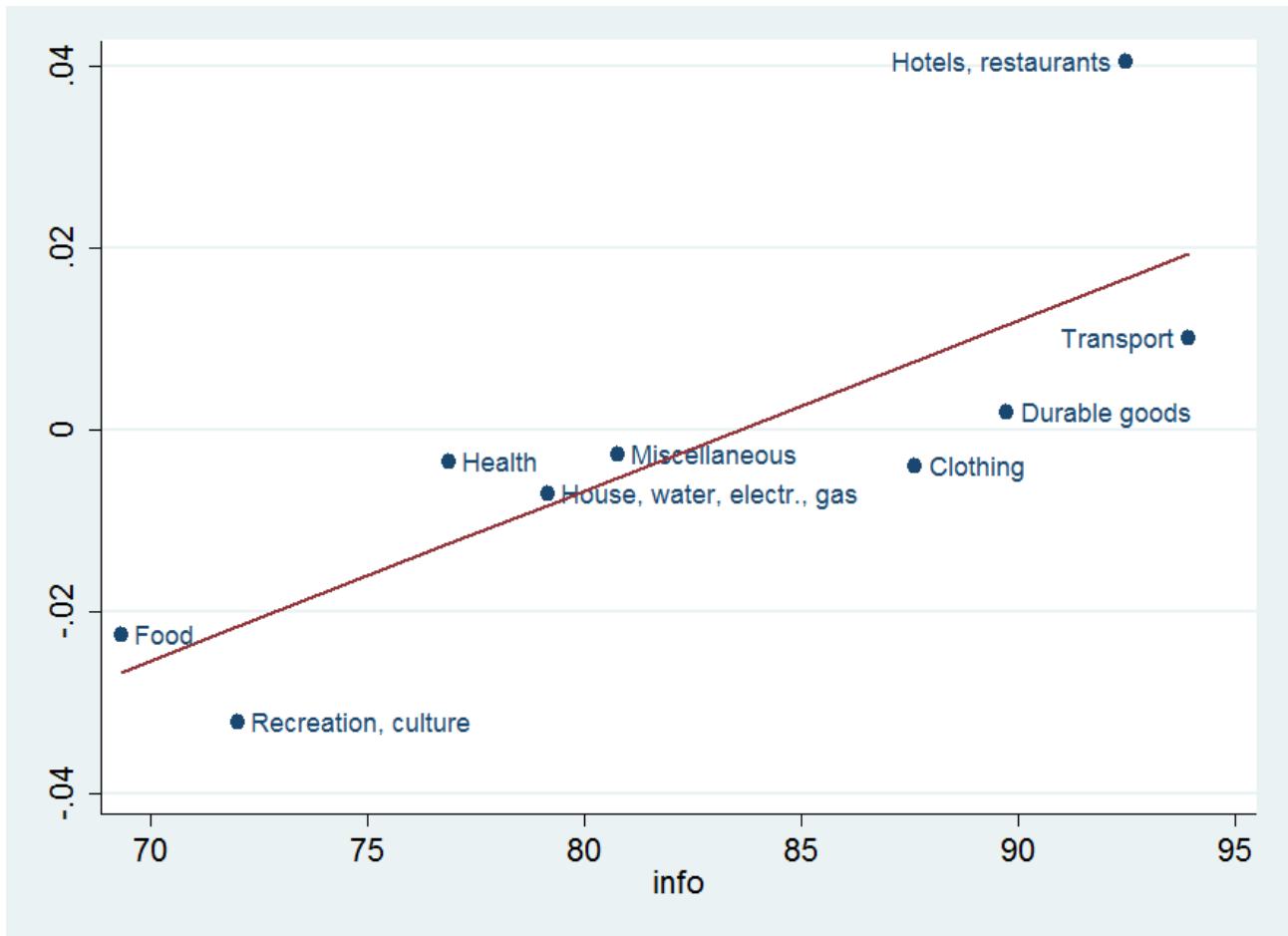


Figure 2.4: Price response and information

Note: Price response estimated in table 2.4 against information content from Abernathy and Franke (1996).

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Chapter 3

Competition and innovation

This chapter presents the first paper I wrote, which has meanwhile been published as a University of Vienna working paper.

3.1 Abstract

The Dixit-Stiglitz model is extended by the possibility for firms to undertake process innovation. The model can provide an explanation to describe the relationship that research activity of firms is positively correlated with product market competition at low levels of competition, and negatively at high levels that has been described in the data. In the model, the initial positive relationship is caused by an increased business stealing opportunity with more competition, while the negative effect comes from the Schumpeterian effect of a reduction of the markup due to higher competition. This framework may also be used to explain the inverted-U relationship found between competition and advertising expenditures.

3.2 Introduction

Joseph Schumpeter [1943] is widely associated with the idea, that firms should be allowed to exercise some market power to increase their incentive to innovate. Ever since the relationship between innovation and competition intensity of firms has created large interest in the literature. Despite vast recent progress in the empirical understanding of this question, the debate is far from being settled theoretically.¹ The main contribution of this paper is to suggest a new explanation for the observed empirical regularity of an inverted-U.

¹One of many good overviews of the theoretical debate on the relationship of industrial organization and innovative activity is given by Vives [2006], who also demonstrates that for Cournot and Bertrand markets a positive relationship should be expected.

Already Dasgupta and Stiglitz [1980] summarized the ambiguous empirical findings that "up to a point industrial concentration is positively correlated with innovation activity, it is negatively correlated when an industry is too concentrated" (page 266). Given this observation, which largely rests on the work of Scherer [1970], a recent paper by Aghion, Bloom, Blundell, Griffith and Howitt [2005a] (furthermore ABBGH) suggested that empirically there may be an inverted-U relationship between the Lerner index (to measure the intensity of product market competition) and patents (as a measure of innovation). According to this hypothesis, the highest researching markets will be those that provide some market competition while still letting firms exercise a certain degree of market power. Other studies have presented evidence which confirms this finding for various datasets (for example Hashmi [2008]), and as well on industry level as on firm level (for a firm level investigation see for example Carlin et al. [2004], and a firm level case study for the automotive industry Van Biesebroeck and Hashmi [2007]).

In their paper ABBGH provide a theoretical explanation in the framework of two firms and three possible interrelations. A firm may either be innovation leader or follower, or firms may be on par. In their model increasing competition reduces the profits of firms on equal level of innovation, which has two effects: On the one hand it raises the incentive to "escape competition", to get ahead of ones competitors when firms are on equal level of innovation. On the other hand a follower has less incentive to catch up with the leader, since in the resulting state of equal innovation level the profits are less. The decreasing mechanism is called the "Schumpeterian effect of competition". In their model the positive and negative effect described balance each other in such a way that for some parameters they indeed generate the inverted-U pattern.

Some empirical doubt has been cast on this model by Hashmi [2008] who found this inverted-U relationship to be robust in the data, but who rejected some other predictions of the ABBGH model. Particularly he found in the data that "it is possible that the relationship between competition and innovation is inverted-U regardless of the technology gap" (page 17), while the described "escape competition" effect is only sensible in markets in which firms are close in levels of technology.

In search for an additional explanation I introduce process innovation into a Dixit Stiglitz setting. This model of monopolistic competition is appealing because it creates a competitive environment for firms while still letting them exercise some market power. As Paul Krugman observed: "This framework, while admittedly special, is remarkably powerful in its ability to yield simple intuition-building treatments of seemingly intractable issues" (Krugman [1991]). This paper is written in the same spirit.

Some other attempts have already been made to analyze process innovation in the Dixit Stiglitz framework. Some first steps into this direction have been undertaken for example by Montagna [1995] and Melitz [2003], who have demonstrated the workings of the model using a certain form of heterogeneity in marginal costs. An example of a model using process innovation in this setting has been brought forward by Gtz [1999] and by Ederington and McCalman [2008], who study the timing of innovation and technological diffusion in a related framework.

A further related work is the dissertation of Georg Gtz [1996], who derives a related model involving a binary research decision of firms. Gtz found a similar relationship between competition and innovation on aggregate market level. I extend his model by allowing firms to have continuous innovation efforts. In this generalized version of the model from Gtz I can show that theoretically an inverted-U relationship may be found on firm level as well (as found by the authors mentioned above in the data). Further I will analyze the reaction of the innovative activity of firms with respect to the fixed costs.

Another attempt has been brought forward by Aghion and Griffith [2005b], who have analyzed the relationship between product innovation and competition in the Dixit Stiglitz model. They interpret product innovation to be equal to the number of firms in the market. They come to the conclusion that in the Dixit Stiglitz model "product market competition [...] reduces post-entry rents and therefore discourages entry (or innovation)" (page 12). I do not restrict innovation to describe solely the entry of new firms, but focus on process innovation. My results show that in fact, despite innovation forcing some firms to leave the market, cost reducing technologies may occur. The relationship of innovation and competition can have increasing and decreasing parts, and under fairly general assumptions the pattern will be of an inverted-U shape.

The model derived in the following pages unfolds as follows: At first firms with identical cost structures form the stable Dixit Stiglitz equilibrium. At one point firms simultaneously get the possibility to invest in a new cost reducing technology (innovate). Each firm maximizes its profits by choosing its innovation level and its prices before and after innovation. Additionally each firm has to form beliefs on the innovative activity of its competitors to determine its optimal innovation level. Doing so they can anticipate the unique Nash equilibrium of zero profits net of innovation costs.

The inverted-U found is created due to different reasons than in the paper by ABBGH. Their "escape competition" effect is not present in my model, and such incentives don't exist. Even without modeling such an effect, the inverted-U relationship on firm and market level can be found in my model, in which the increasing part is alternatively explained by a greater business stealing opportunity with more innovation. In a market with large substitutability one firm can attract customers from the other firms by reducing its price, which is less effective in a market with little or no competition.²

The decreasing part of the inverted-U is due to the same Schumpeterian effect of competition like in the model by ABBGH: Tough competition reduces the markup of firms, and therefore the post-innovation rents.

To demonstrate the low innovation incentive at the extremes, consider the extremes: In markets with tough competition the firms operate close to the margin and can hardly generate profits. In the Dixit Stiglitz environment this will also be true for post-innovation profits, which reduces the incentive to

²The idea of a business stealing effect has been expressed in other contexts for example by Aghion and Howitt [1992], Grossman and Helpman [1991], Segerstrom [1998]. In a more similar context the idea has been expressed by Raith [2003]. In these models an innovator can fully crowd out a competitor by innovating. The business stealing effect described here differs, since undercutting other firms will not necessarily drive them out of the market, but just decrease their demand.

undertake expensive research efforts. If on the other hand competition is low, the firms do not feel the pressure from substitution, and serve one market segment with large room for pricing flexibility. Innovation and the resulting price cuts in such markets will not attract much additional demand, which makes cost reductions less valuable to firms.

While elements of this understanding of the problem have been suggested in the literature³, the model combines these to create a compact framework that generates the inverted-U pattern.

This paper is organized as follows: After stating the assumptions of the model, a general version of it is derived. After the discussion of some properties (most noteworthy the conditions to find an inverted-U), the model is solved using an example for a particular innovation function. Further it is shown that the model could be also interpreted as a model of advertising. A conclusion concludes.

3.3 The model

The framework in which I study innovation is an extension of the Dixit Stiglitz model of monopolistic competition, which is additionally extended by the option for firms to undertake process innovation. Like in their model, the aggregated demand from consumers follows a CES utility function. Let x_i denote the total quantity of good i that is consumed, and θ be an exogenous parameter. Then the utility function is:

$$U(x_1, x_2, \dots, x_n) = \left[\sum_{j=1}^n x_j^\theta \right]^{\frac{1}{\theta}}. \quad (3.1)$$

It is assumed that $0 < \theta < 1$, which ensures that the goods are substitutes. If θ approaches one, the demand function becomes linear in x_i , and the goods become perfect substitutes. A reduction of θ reduces the willingness of consumers to substitute one good for the other. It follows that θ is a parameter that can be used to smoothly adjust competition in this model. Another possibility to adjust competition would be to change the number of firms; given however that in this model the number of firms is endogenous, I will use the parameter θ as the parameter to adjust competition, and interpret changes of θ as changes of competition. Also the Lerner index, which was used in the ABBGH paper and others to measure competition, is in this model a function of θ only. The case of changing barriers to entry (a change of the fixed costs f) will also be discussed later.

Further I assume that the total consumer income is I in every period, and that in each period the full amount of income is spent on the consumption goods x . It may be argued that the assumption of constant income is in this context overly restrictive, since it is widely believed that innovation increases income. But innovation does still increase the relative income in this model despite assumption two,

³For example Vives [2006] has found that the relationship between the elasticity of substitution and process innovation should be positive in Cournot and Bertrand settings. Raith [2003] showed that with more elastic firm - level demand functions there is a greater business stealing opportunity (page 1246).

since it lowers prices and with a fixed income therefore increases purchasing power. Also the constancy of income is not crucial to the result; the model could be modified in a way to increase I directly in the post-innovation equilibrium. If this increase is not assumed to be too large, the shape of the competition - innovation relationship and all the qualitative predictions would stay the same (only the numerical results would shift as a consequence, if the model is solved using an explicit cost function).⁴

In the initial equilibrium, the cost function of firms is fully characterized by a fixed cost f and a variable cost c , which are both constant for all firms in the initial innovation. Innovation can then serve to lower the marginal cost, in the following way: A one time research investment of ω_i today lowers the marginal costs of firm i from c to $c(\omega_i)$ in the future. Innovation thus only affects the per-unit production costs and not the entry to market. It can be thought of as the purchase of new machines, which work faster than the ones they replace but also require a one time investment. It is this assumption by which the model discussed here differs from the Dixit-Stiglitz model.

It is reasonable to assume that a cost reducing investment (a process innovation) of ω should have the following relationship with marginal costs c : $c(\omega_i) > 0$, $c'(\omega_i) < 0$ and $c''(\omega_i) > 0$. This description requires that marginal costs will always be positive, decrease as a consequence of research effort, but this decrease happens at a declining rate; the impact of the marginal dollar spent on research is smaller the larger the research effort. An example of the form $c(\omega_i) = 1/\omega_i$ (which is one of the most simple functions to fulfill these three properties) is derived later.

Hence there are three cost elements that a firm faces: marginal costs $c(\omega_i)$, which are initially identical for all firms, but can be lowered, fixed costs f , which are constant in all every period. Finally a firm has the option to pay research costs ω_i , which have to be paid once and are sunk costs thereafter.

In this model, innovation may also be thought of as producing a higher quality variety after a one time investment while leaving marginal costs unchanged. Another possible view of the model would be, to interpret it as a model of advertising. The interpretation of the model as a model of advertising will be developed below.

Next I assume that the number of firms is large. This assumption may be restated such that firms ignore the impact of their price on the income of consumers (whose purchasing power changes as a result of a price change). This assumption is necessary to justify a certain Dixit Stiglitz simplification when computing the price elasticity. See also the derivation of equation 3.3 in the appendix. Finally, there is free entry to the market at any point in time, which validates the use of a zero profits condition.

⁴Since the assumption will be made that the number of firms is large, such an increase of income due to innovation would be of little strategic relevance to one single firm.

3.4 Equilibrium

First I will derive the initial Dixit Stiglitz equilibrium, then analyze the innovation incentive, and then analyze the new stable equilibrium and the conditions under which it will be observed. For most of the following equations a more detailed derivation is given in the appendix. From the utility function and the income of the consumers follows, that the optimal demand for good x_i is fully determined by the prices of all firms and the income of the consumers I (see appendix).

$$x_i = \frac{I p_i^{\frac{1}{\theta-1}}}{\sum_{j=1}^n p_j^{\frac{\theta}{\theta-1}}} \quad (3.2)$$

From this result, and the assumption on the cost structure follows the optimal pricing strategy of a monopolist, using further the assumption that the number of firms is large. Initially all firms have the same constant marginal costs equal to c . Then (see appendix):

$$p_i = \frac{c}{\theta}. \quad (3.3)$$

Combining equation 3.2, equation 3.3, and the zero profit condition which must hold given that free entry is assumed, the number of firms in the initial equilibrium is determined by (see appendix):

$$n = \frac{(1 - \theta)I}{f} \quad (3.4)$$

So far these results follow Dixit Stiglitz [1977]. Now the model is extended by the introduction of the possibility to innovate, which implies also an extension to two periods. Let n_1 denote the number of firms that will be selling a positive quantity in the new equilibrium (in the second period). Let further r denote the constant interest rate at which firms can obtain credit. Then the profits of an innovating firm Π^I will be (see appendix):

$$\Pi^I = \left(\frac{1}{1 + r} \right) \left(\frac{(1 - \theta)I c(\omega_i)^{\frac{\theta}{\theta-1}}}{\sum_{j=1}^{n_1} c(\omega_j)^{\frac{\theta}{\theta-1}}} - f \right) - \omega_i \quad (3.5)$$

The expression $\left(\sum_{j=1}^{n_1} c(\omega_j)^{\frac{\theta}{\theta-1}} \right)$ will be called the innovation index. The innovative activity of firm j influences the profit of firm i only through this innovation index, and it does so negatively. This externality of research is capturing the negative side of the business stealing effect; the loss of consumers due to rivals research activities. This effect also mathematically operates through demand (compare with equation 3.2).

The maximization problem of this profit function with respect to ω_i may not yield a positive solution for ω_i . In this case no innovation would take place. Given the assumptions that $c(\omega_i) > 0$ and

$c'(\omega_i) < 0$, as can be observed from the first order condition of this problem, the solution for ω_i will be unique, provided that it is positive for all values of θ .

The innovation index of the initial equilibrium is equal to $nc^{\frac{\theta}{\theta-1}}$. Given the free entry assumption the innovation index can never be smaller than that in the new equilibrium. If it were, the entry of non-innovators would increase the index. Hence the equilibrium innovation index can only be greater or equal to the original one. Thus the number of firms in the new equilibrium n_1 must be less or equal to the number of firms in the initial equilibrium n . Due to this negative externality from innovation in this model (the business stealing effect), some firms may be forced to leave the market. Also due to the zero profit condition in the initial equilibrium all non innovators will be driven out of the market if the innovation index is greater than the one of the initial equilibrium, since at this initial value firms just break even.

In equation 3.5 the positive and the two negative effects of competition (measured by θ) on profits are visible. On the one hand an increase of θ decreases the markup $(1 - \theta)$. This is what has been called earlier the Schumpeterian competition effect. On the other hand the exponent of $c(\omega_i)$ will be more negative as a consequence of an increase of θ . Hence the impact of a reduction of marginal costs on profits is larger, and a decrease of costs more valuable to firms. This second effect comes from the fact that price differences result in larger business stealing possibilities if competition is tougher. If a good has many close substitutes, a price reduction of that good results in a larger increase in demand as compared to the situation when there are no substitutes.

When deciding how much to innovate, each firm can only influence its own research output, but takes the research effort from the other firms as given. Let $V = \sum_{j \neq i} c(\omega_j)^{\frac{\theta}{\theta-1}}$ be the innovation index of all firms but innovating firm i . Then firm i will take V as constant, and solve the following profit maximization problem:

$$\omega_i^* = \arg \max_{\omega_i} \left[\left(\frac{1}{1+r} \right) \left(\frac{I(1-\theta)c(\omega_i)^{\frac{\theta}{\theta-1}}}{c(\omega_i)^{\frac{\theta}{\theta-1}} + V} - f \right) - \omega_i \right] \quad (3.6)$$

Setting the first derivative of this problem with respect to ω equal to zero implies:

$$\frac{\theta I}{1+r} \left(\frac{c(\omega_i)^{\frac{\theta+1}{\theta-1}} c'(\omega_i)}{(c(\omega_i)^{\frac{\theta}{\theta-1}} + V)^2} - \frac{c(\omega_i)^{\frac{1}{\theta-1}} c(\omega_i)'}{c(\omega_i)^{\frac{\theta}{\theta-1}} + V} \right) - 1 = 0 \quad (3.7)$$

As demonstrated in the appendix, a sufficient condition for the second order derivative to be smaller than zero is that $c(\omega_i) > 0$, $c''(\omega_i) > 0$, $c'(\omega_i) < 0$ and $n_1 > \max\{1, 2\theta\}$. The three conditions on the cost function are reasonable qualities, and when describing the assumptions of the model the cost function was defined to have these properties. The requirement on the number of firms to be large is not restrictive by assumptions. Hence the solution to equation 3.6 will be a maximum in all feasible situations.

To come to a proper solution firm i must form beliefs on the innovation of the other firms (the value

of V). Given the initial symmetry of firms and the unique solution to the problem of maximizing firm profits with respect to ω_i (provided that this solution is positive), firm i can anticipate that other firms who face the identical maximization problem will come to the same solution like itself. Analogue to the usual derivation of the Cournot equilibrium, a symmetry condition on the first order condition derived can be imposed. Then a firm can anticipate that $V = (n_1 - 1)c(\omega_i)^{\frac{\theta}{\theta-1}}$, where again n_1 is the number of firms that will be present in the new equilibrium. Let ω^* be the optimal research effort in equilibrium. Imposing this symmetry condition on the first order condition 3.7 implies that:

$$-\frac{c(\omega^*)}{c(\omega^*)'} = \frac{\theta I}{1+r} \left(\frac{n_1 - 1}{n_1^2} \right). \quad (3.8)$$

A second condition that can be anticipated is that in the emerging equilibrium the free entry will again lead to the abolishment of positive profits. As shown before, each innovator reduces the profits of the other firms. If expected profits after innovation are greater than zero there would be money left on the table and more firms would innovate. Each innovator reduces the expected profits after innovation, in the evolving Nash equilibrium profits are equal to zero.

If too many firms innovate, profits including research costs may be negative. In this case firms may still decide to stay in the market, since research costs are sunk, and in every following period the fixed costs may be covered by sales. Ex post the innovation decision is not optimal in this case. Hence profits including research costs in the new equilibrium will be less or equal to zero. Despite having a possible solution with negative long run profits, the only relevant ex ante assumption is that innovating firms assume long run profits to be exactly equal to zero, since no firm would innovate given expected negative profits.

From the profit function 3.5, noting again that $V = (n_1 - 1)c(\omega_i)^{\frac{\theta}{\theta-1}}$ this zero profit condition requires that:

$$\omega^* = \frac{1}{1+r} \left[\frac{(1-\theta)I}{n_1} - f \right] \quad (3.9)$$

The situation described by condition 3.8 and condition 3.9 defines the unique Nash equilibrium in two equations with two unknowns (the research effort ω^* and the endogenous number of firms n_1), which determine the equilibrium of the model. These equations can be solved once a particular form of the cost function $c(\omega_i)$ is assumed. One example is given later in this paper.

For the equilibrium to be valid, it has to be verified that the new innovation index is larger than the old one. If that was not the case, non-innovating firms would enter the market, thereby increasing the innovation index, until it reaches the initial level. For this condition to hold, certain parameter values have to be excluded. At these parameters, no innovation will take place. This condition can not be stated for the general case, but will be derived for an explicit solution of this model later.

3.5 Equilibrium Properties

The inverted-U on firm level: There are several ways to measure competition [Boone et al. 2007]. As noted before, in this paper the elasticity of substitution θ is interpreted to measure competition. The same interpretation of θ is found often in the literature; among others by ABBGH, who write in the footnote on page 710: "Increased product market competition is modeled [...] as an increase in the substitutability between differentiated products in Dixit and Stiglitz [1977]."

As can easily be verified, the Lerner index to measure market power is given by $(1 - \theta)$, and hence depends directly and only on θ . The Lerner index was also the number used to measure competition in the empirical investigation of ABBGH in which the inverted-U was described and in many other studies.

For this reason the relationship between ω^* and θ is analyzed further. Differentiating equation 3.8 and equation 3.9 with respect to θ gives the following two conditions:

$$\begin{aligned}\frac{\partial \omega}{\partial \theta} &= \frac{I}{1+r} \left(-\frac{1}{n_1} - \frac{(1-\theta)}{n_1^2} \frac{\partial n_1}{\partial \theta} \right) \\ \frac{\partial n_1}{\partial \theta} &= \frac{n_1(n_1 - 1) - \frac{(1+r)n_1^3}{I} \left(\frac{c(\omega)c(\omega)''}{(c(\omega)')^2} - 1 \right) \frac{\partial \omega}{\partial \theta}}{(n_1 - 2)\theta}.\end{aligned}$$

Combining these two equations yields

$$\frac{\partial \omega}{\partial \theta} = - \left(\frac{I}{(1+r)n_1} \right) \frac{n_1 - 1 - \theta}{(n_1 - 2)\theta - (1 - \theta)n_1 \left(\frac{c(\omega)c(\omega)''}{(c(\omega)')^2} - 1 \right)}. \quad (3.10)$$

This equation gives the impact of a change in competition on innovation, thus it describes the relationship of interest. If it is positive for a small value of θ , and negative for a large value of it, its form can be described as an inverted-U.

The first observation is that when θ approaches 1, this equation will be negative for all parameter values. If θ approaches to 1 the second fraction converges to $(n_1 - 2)/(n_1 - 2) = 1$ if c' is not equal to zero, which was assumed. The fraction in brackets is always positive, hence the equation is indeed negative as θ approaches 1.

By assumption 4 it should hold for all valid parameters that $n_1 > 2$. Then as θ approaches zero, it can be easily verified that the equation will be positive iff:

$$c(\omega)c(\omega)'' > \left(c(\omega)' \right)^2. \quad (3.11)$$

Equation 3.11 is fulfilled for all cost functions of the form $c(\omega) = \omega^x$ with x being a negative number

(the model will be solved for the case of $x = -1$ next), for $-\log(x)$ and also for a large number of other functions.

Hence given equation 3.11 holds for all values of ω , the relationship between innovation and competition can be expected to be increasing in the area of $\theta = 0$, and decreasing in the area of $\theta = 1$, with a single change of slope in between. If parameter restrictions don't cut off the maximum, this would result in the observation of what could be called an inverted-U.

If condition 3.11 is not fulfilled at all feasible values of θ then the relationship of competition and innovation will be decreasing only. The interpretation of this finding is, that the slope is so steep (the cost reduction as a consequence of an increase of ω is so high), that this reduction outweighs the negative effect of little competition.

It may be with some functions $c(\omega)$ that equation 3.11 holds in the area of $\theta = 0$ (note that ω depends on θ), but not for all possible values of θ . Then the relationship may be characterized by more than one change of direction. It would still be increasing at the minimal and decreasing at the maximal value of θ , but could be of a shape that changes the sign of the slope more than once in between.

The inverted-U relationship on firm level with varying I and with varying f is shown in figure 1 for the situation of the example analyzed in the next section. The inverted-U pattern is clearly visible. An increase of I will ceteris paribus unambiguously increase research effort, while the role of an increase of f is less clear. This role is discussed shortly later in this section.

The inverted-U on market level: Also the joint output of firms will follow this inverted-U pattern, when market research effort is measured as the number of firms (n) times the research output of one firm (ω^*). This feature is similar to the one described by Gtz [1996] in his dissertation, who found the same result in a related model with a binary choice for innovation of firms.

The role of f : The parameter f describes the fixed costs of firms, and hence also the market entry barriers. In the model developed in this paper, the effect of a variation of entry barriers on innovation is ambiguous. This can be seen directly in equation 3.9, which holds for general research functions.

The first observation which follows from this equation is that the partial derivative $\partial\omega^*/\partial f = -(1+r)^{-1}$, which is strictly smaller than zero. This observation simply acknowledges that fixed costs and research costs can be substituted one for the other to make the zero profits condition hold, and that hence a fixed cost increase would tend to reduce research activity.

However, there are more effects at work. The second observation from this equation is that also the derivative $\partial\omega^*/\partial n_1 = -(1+r)^{-1}(1-\theta)I/n_1^2$ is smaller than zero. Hence a partial increase of the number of firms will decrease the research activity of each firm. If there are less firms they can spread the research costs over a larger base, and hence have an incentive to innovate more.

In the general setting n_1 can not explicitly be stated. Given however that f is the barrier to market entry, it can be assumed that an increase of the market entry fee f leads to an equilibrium consisting of less firms. Therefore $\partial n_1/\partial f$ should also be smaller than zero. In the example given in the next section this is clearly the case, and it should be expected in general for sensible parameters.

Since $\partial\omega^*/\partial n_1 < 0$ and $\partial n_1/\partial f < 0$, there is also a positive effect of f on the research activity of firms via its influence on the number of firms. The effect from lowering or raising the entry barriers for firms to access a certain market on the research activity of firms operating in that market can thus be ambiguous.

The intuition is that on the one hand an increase of entry barriers will create less and therefore larger firms that can more easily afford large research spendings, but on the other hand increase the costs of these firms and hence make the zero profits condition harder to comply.

A graphical representation of this relationship is given for the example analyzed in figure 1. The lines intersect, which means that ceteris paribus it is not clear if an increase of f will increase or reduce the research output of a given firm. Examples for both effects can easily be constructed using figure 1.

Welfare: Innovation in this model has two impacts on utility. On the one hand it lowers costs, and therefor prices, which benefits consumers. On the other hand it reduces the number of firms and hence reduces the number of varieties. It is therefor interesting to compare the utility of the two equilibria. This comparison yields, that the utility is higher in the situation allowing process innovation than in the initial equilibrium if

$$n_1 c(\omega^*)^{\frac{\theta}{\theta-1}} > n c^{\frac{\theta}{\theta-1}}. \quad (3.12)$$

This is exactly comparing the old and the new innovation index, utility will be larger if the innovation index is. But as established before, the new innovation index can not be smaller than the initial one, since otherwise non-innovators have an incentive to enter the market. Their entry would increase the innovation index until it reaches the initial level. Hence in all situations in which innovation takes place, it will do so to the benefit of the consumers.

The market solution need not be socially optimal, and can differ from the choice of a social planner. For example for certain non-convex cost functions $c(\omega)$ the social planner decision need not yield a symmetrical solution. If the solution is symmetric, the social planner would maximize utility minus costs:

$$\max_{\omega, n, x} \left[\left(\frac{1}{1+r} \right) \left((x^\theta n)^{\frac{1}{\theta}} - n\omega - nf \right) - nc(\omega) \right].$$

The partial derivative with respect to ω yields, that a social planner would determine the research effort per firm according to $-c(\omega)' = 1/(1+r)$. This can be larger or smaller or identical to the market solution. The number of firms and the quantity of good produced can vary accordingly. Hence only for a specific set of parameters the market solution is socially optimal, and generally it is not.

3.6 An example

In this section I will assume that $c(\omega_i) = \min\{c, c/\omega_i\}$. This means that for example a research investment by a firm of 2 allows that firm to halve its marginal costs. Obviously under this assumption the optimal innovation effort can only be a value larger than one if it is positive, or zero otherwise.

Combining the equilibrium conditions 3.8 and 3.9 gives a quadratic equation for the number of firms n_1 , that always has a positive and a negative solution. Since the number of firms can not be negative, only the positive solution is relevant. Then there is a unique solution for the number of firms in equilibrium. It is given by:

$$n_1 = \frac{I}{2f} \left(1 - 2\theta + \sqrt{(1 - 2\theta)^2 + \frac{4\theta f}{I}} \right). \quad (3.13)$$

Just like in the initial equilibrium, the number of firms depends on the ratio of consumer income over fixed cost. The corresponding research effort of one firm is also unique, and given by the following equation (which is also shown graphically in figures 1:

$$\omega^* = \frac{f}{1+r} \left[\frac{1 - \sqrt{(1 - 2\theta)^2 + \frac{4\theta f}{I}}}{1 - 2\theta + \sqrt{(1 - 2\theta)^2 + \frac{4\theta f}{I}}} \right]. \quad (3.14)$$

Partial derivatives show that a higher interest rate has a negative effect on innovation effort, which is expected given the assumptions. An increase of the income of the consumer income will increase the research effort, which should also be expected. Finally the already discussed ambiguous effect of the fixed costs f on research effort is clearly visible in this equation. In the equation as presented, f shows up three times. An increase of the first f has a positive effect on ω^* , while an increase of the other two f s has a negative effect. The partial derivative is given by:

$$\frac{\partial \omega^*}{\partial f} = \frac{\omega^*}{f} - \frac{f^2}{(1+r)^2 \omega^*}.$$

For any ω^* this relationship will be positive if f is small. Hence in markets with low entry barriers an increase of them will increase the research output of the remaining firms. For larger values of f the relationship may become negative.

Innovation as described will not take place for all possible parameters. The new innovation index has

to be larger than the old one for this solution to hold. This is fulfilled if

$$r \leq f \frac{\left(1 - \sqrt{(1 - 2\theta)^2 + \frac{4\theta f}{I}}\right) \left(1 - 2\theta + \sqrt{(1 - 2\theta)^2 + \frac{4\theta f}{I}}\right)^{\frac{1-2\theta}{\theta}}}{(2 - 2\theta)^{\frac{1-\theta}{\theta}}} - 1. \quad (3.15)$$

If equation 3.15 is fulfilled, additionally it must hold that ω^* has to be larger than one. This comes from the definition of the research function. Equilibria which predict a research effort of less than one have to be ruled out, which requires additionally

$$f > (1 + r)(1 - 2\theta) \quad (3.16)$$

$$I > \left(\frac{\theta}{1 - \theta}\right)(1 + r) \frac{\left(\left(\frac{1}{1+r}\right)f + 1\right)^2}{\left(\theta f \left(\frac{1}{1+r}\right) + 2\theta - 1\right)}. \quad (3.17)$$

The condition on f is not overly restrictive given that r is small. It is also fulfilled for all values of $\theta \geq 1/2$. The threshold of I is potentially large, particularly if f is large, but this is in line with assumption four that the number of firms in the initial equilibrium $n = (1 - \theta)I/f$ is large.

If condition 3.15 is an equality, non-innovating firms may survive. Then all firms assume that the new innovation index will equal the initial one. If in this case too few firms innovate, profits would still be zero for the innovators. A new equilibrium consisting of both, innovating and non-innovating firms could establish. For all other parameters for which innovation takes place, non-innovators will be forced to leave the market, given the increase of the innovation index.

For this example the inverted-U, and how it changes with I or f is graphically presented in figure 1.

3.7 A note on advertising

In the introduction it was already remarked that advertising could be modeled in a similar way like process innovation is described in this model, and that hence this model may be alternatively interpreted as a model of advertising. Process innovation as interpreted here and throughout the literature allows firms to lower production costs permanently after a one time payment. An interpretation for advertising could be, that it allows firms to increase demand in every period through the payment of a certain sum (denoted by $C(\psi)$) in every period. Thus $C(\psi)$ denotes the per period advertising expenditure of a firm, and ψ is a parameter, to adjust how consumers react to it.

To model the effect of ψ in this model, one possibility to model advertising would be to rewrite the utility function as: $U = [\sum_{i=1}^n (\psi_i x_i)^\theta]^\frac{1}{\theta}$. Analogue to the case of process innovation, which was

analyzed so far, a firm can increase the demand for its product linearly by paying $C(\psi)$ with $\psi > 1$. Hence a payment of ψ would raise utility and further also demand. Solving the consumer maximization problem, demand is then given by:

$$x_i = I \frac{p_i^{\frac{1}{\theta-1}} \psi_i^{\frac{\theta}{1-\theta}}}{\sum_{j=1}^n \left(\frac{p_j}{\psi_j} \right)^{\frac{\theta}{\theta-1}}} \quad (3.18)$$

The price elasticity stays the same, and also the firm pricing condition, which will be independent of ψ . Then the cost of an advertising firm can be expressed as $C(\psi)$, whereby it is assumed that advertising costs have to be paid every period to achieve a permanent effect (contrary to research expenditures, which have to be paid once).

$$\Pi_i = \frac{1}{1+r} \left(\frac{I(1-\theta) \psi_i^{\frac{\theta}{1-\theta}}}{\sum_{j=1}^{n_1} \psi_j^{\frac{\theta}{1-\theta}}} - f - C(\psi) \right) \quad (3.19)$$

The function $C(\psi)$ denotes the cost from advertising an amount ψ in every period. If the costs of advertising are thought to be similar to the way in which costs to innovation were modeled, this equation is mathematically equivalent to equation 3.6. Hence this model could also be used to predict an inverted-U relationship between competition and advertising. In the same way the model may also be interpreted as a model of increased product quality, which could also be thought of as leading to an increased demand as a consequence of some investment.

Indeed some evidence for an inverted U-relationship between advertising and competition has been found in the data. First Sutton [1974] found empirically "support for the inverted-U hypothesis" (page 62) between competition and advertising. More recently Lee [2002] remarked on the literature on the relationship between advertising and competition that it has become conventional wisdom to assume "the so called inverted U hypothesis, which implies that moderately concentrated industries engage more intensively in advertising than both atomistically competitive and highly concentrated industries" (page 89). Further also he confirmed this inverted-U relationship between competition and advertising in consumer good industries.

Hence a second testable prediction of the model described (that we should expect an inverted-U relationship between innovation and advertising) is confirmed by empirical investigations of the subject.

3.8 Conclusion

In this paper a model is presented that provides an alternative explanation for the observed inverted-U relationship between product market competition and innovation. It is derived on the basis of

the standard Dixit-Stiglitz model. The model predicts that *ceteris paribus* markets with medium competition should exhibit a tendency to create more innovation than those markets on the extremes. For a large general set of innovation functions this result holds theoretically for firm level innovation as well as for aggregate innovation activity.

The increasing part of this inverted-U is explained by a larger business stealing effect (the possibility to attract consumers from opponents by lowering costs), which is higher in markets with more competition. The decreasing part is explained by the common "Schumpeterian effect of competition", which states that more competition decreases post-innovation monopoly rents.

The ambiguous relationship of innovation with respect to market entry barriers is discussed using an explicit research function. While in markets with low entry barriers an increase of these barriers should raise the innovation effort of firms, the effect may be opposite in markets that already have large barriers to entry.

Hence the model suggests a new hypothesis to understand the empirical regularity of an inverted-U relationship between competition and innovation. Additionally the model can also be used to explain the inverted-U hypothesis found between product market competition and advertising expenditures.

Further it provides a new compact framework to study the effect of various policies affecting market competition on innovative activity and advertising in those markets.

Possible further extensions may analyze the case with less restrictive assumptions on the symmetry of firms, for example by introducing heterogeneity in marginal costs. The results may look similar, with an indifferent firm that has zero profits after innovation, but with other firms that operate with lower marginal costs and can generate positive profits. Also the model may be extended to overcome the static nature and have a more dynamic structure with innovation in different periods.

3.9 Appendix 1: Derivations and Proofs

Derivation of equation 3.2: In this model, the budget constraint is given by $\sum_j x_j p_j \leq I$. The utility maximization problem yields then the following relationship between any two goods consumed: $x_i/x_j = (p_i/p_j)^{\frac{1}{\theta-1}}$. Substituting this relationship back into the budget constraint gives the demand stated.

Derivation of equation 3.3: From the derivative of the solution for x_i with respect to its own price p_i follows the exact price elasticity ϵ_i :

$$\epsilon_i = \frac{\partial x_i}{\partial p_i} \frac{p_i}{x_i} = -\frac{1}{1-\theta} + \left(\frac{\theta}{1-\theta} \right) \frac{x_i p_i}{I}$$

Given the assumption that the number of firms is large, the second term in this equation can be

dropped. This simplification has attracted quite some controversy in the literature,⁵ and I do acknowledge that the results only holds if the number of firms is large (assumption four). Then from the Lerner pricing condition given the price elasticity $\epsilon_i = -\frac{1}{1-\theta}$ follows the price setting equation stated.

Derivation of equation 3.4: Since initially all firms have identical fixed and marginal costs c and f , they all charge the same prices $p = c/\theta$ and produce the same quantity x , which equals:

$$x = \frac{Ip^{\frac{1}{\theta-1}}}{np^{\frac{\theta}{\theta-1}}} = \frac{I}{np}.$$

Profits are then given by $\Pi = xp - xc - f = xp(1 - \theta) - f = (1 - \theta)I/n - f$, and since they have to be zero the number of firms n can be determined from this last equation.

Derivation of equation 3.5: Using equation 3.2 and 3.3 the profit in a single period can be calculated. I assume that the fixed and marginal costs have to be paid in the second period also, but the research costs only in the first period. To account for this time asymmetry I discount the transfers that occur in the second period by interest rate r , such that an amount of a in 1 period is of current value $a/(1 + r)$. Then profits of a firm in the period after innovation from perspective of the date when the investment decision has to be made can be developed as follows:

$$\begin{aligned} \Pi^I &= \left(\frac{1}{1+r} \right) (x_i p_i - x_i c(\omega_i) - f) - \omega_i \\ &= \left(\frac{1}{1+r} \right) (x_i p_i (1 - \theta) - f) - \omega_i \\ &= \left(\frac{1}{1+r} \right) \frac{(1 - \theta)I \left(\frac{c(\omega_i)}{\theta} \right)^{\frac{\theta}{\theta-1}}}{\sum_{j=1}^{n_1} \left(\frac{c(\omega_j)}{\theta} \right)^{\frac{\theta}{\theta-1}}} - f - \omega_i \\ &= \left(\frac{1}{1+r} \right) \left(\frac{(1 - \theta)I c(\omega_i)^{\frac{\theta}{\theta-1}}}{\sum_{j=1}^{n_1} c(\omega_j)^{\frac{\theta}{\theta-1}}} - f \right) - \omega_i. \end{aligned}$$

The second order condition of problem 3.6

Writing $W = V + c(\omega_i)^{\frac{\theta}{\theta-1}}$ as the total innovation index, the second order derivative is smaller than zero if

$$c''(\omega_i) \left(\frac{c(\omega_i)^{\frac{\theta+1}{\theta-1}}}{W^2} - \frac{c(\omega_i)^{\frac{1}{\theta-1}}}{W} \right) + \frac{c(\omega_i)'(\omega_i)}{(1 - \theta)W^2} \left(\frac{2\theta c(\omega_i)^{\frac{2+\theta}{\theta-1}}}{W} + c(\omega_i)^{\frac{2-\theta}{\theta-1}} W - (2\theta + 1)c(\omega_i)^{\frac{2}{\theta-1}} \right) < 0$$

⁵See for example the critical comments by Yang and Heijdra [1993], or d'Aspremont et al. [1996], who directly address this point.

After deriving the second order condition, the symmetry condition can be imposed, such that W can be written as $n_1 c(\omega_i)^{\frac{\theta}{\theta-1}}$. Rearranging yields

$$-\frac{c''(\omega_i)}{c(\omega_i)} \left(\frac{n_1 - 1}{n_1^2} \right) + \frac{(n_1 - 1)(n_1 - 2\theta)}{(1 - \theta)n_1^3 c(\omega)^2} < 0.$$

This is fulfilled provided the conditions stated on the cost function and the number of firms hold.

3.10 Appendix 1: Graphs

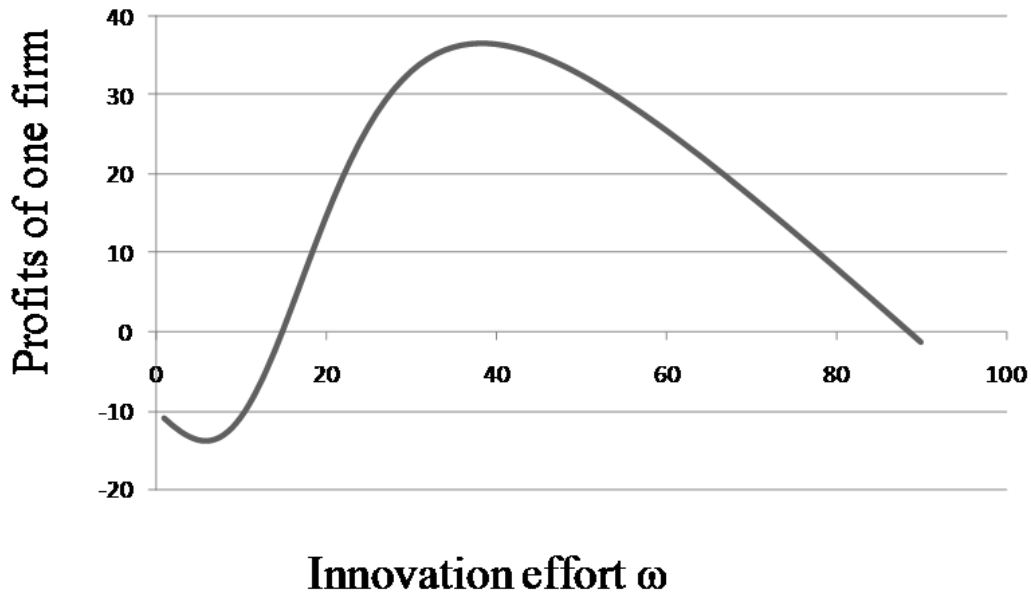


Figure 1: Profits of one firm taking the behavior of other firms as constant. The following parameters are assumed: $\theta = 3/4$, $I(1 - \theta) = 100$, a value for the innovation index of the other firms of 10000, $r = 0.5$ and $f = 10$.

Figure 3.1: Figure 1

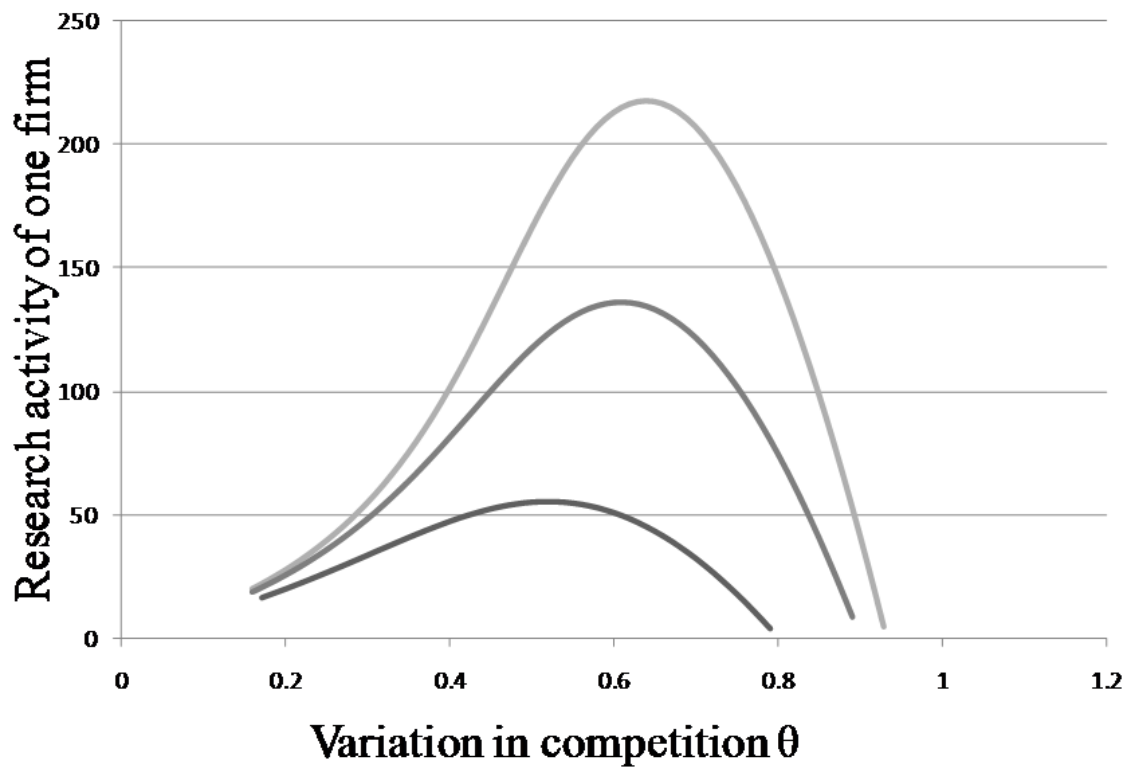


Figure 2: The research effort of an innovative firm as function of market competition. The following parameters are assumed: I is given by 1500, 1000 and 500 (from top to bottom), f is given by 100. Interest rate r is given by 0.05. Values for which either of conditions 11, 12 or 13 are not fulfilled are excluded from the representation.

Figure 3.2: Figure 2

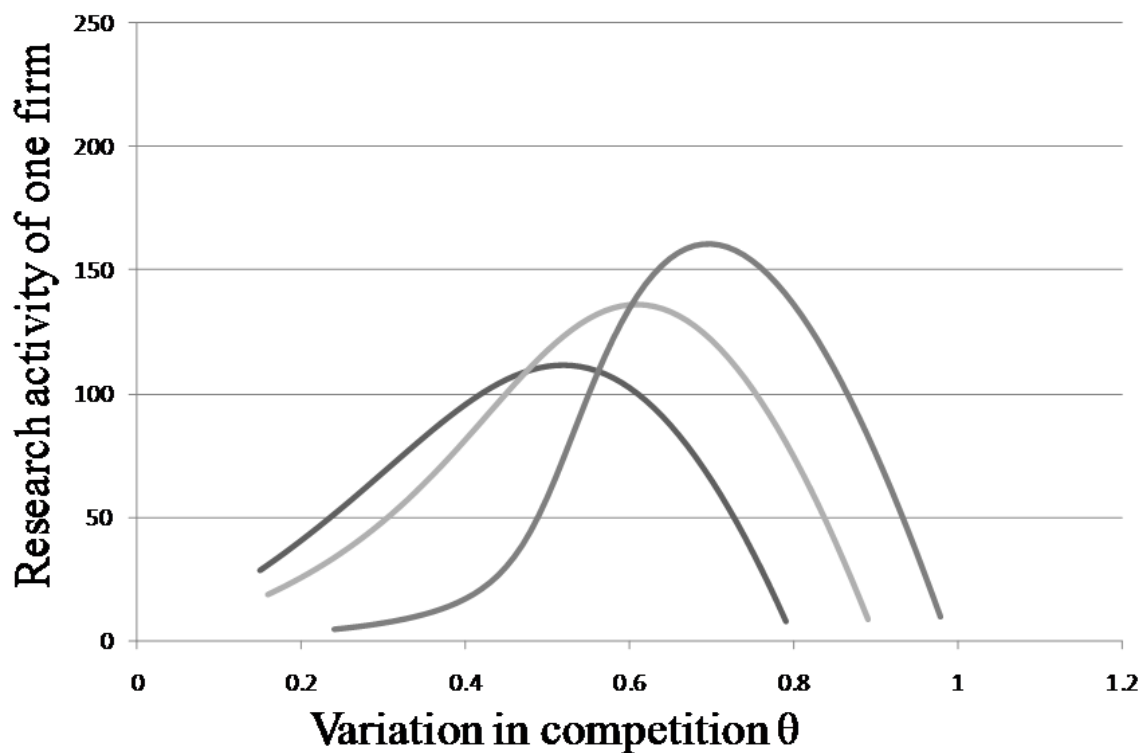


Figure 3: The research effort of an innovative firm as function of market competition. The following parameters are assumed: I is given by 1000, f is (from highest to lowest maximum): 10, 100 and 200. Interest rate r is given by 0.05. Values for which either of conditions 11, 12 or 13 are not fulfilled are excluded from the representation.

Figure 3.3: Figure 3

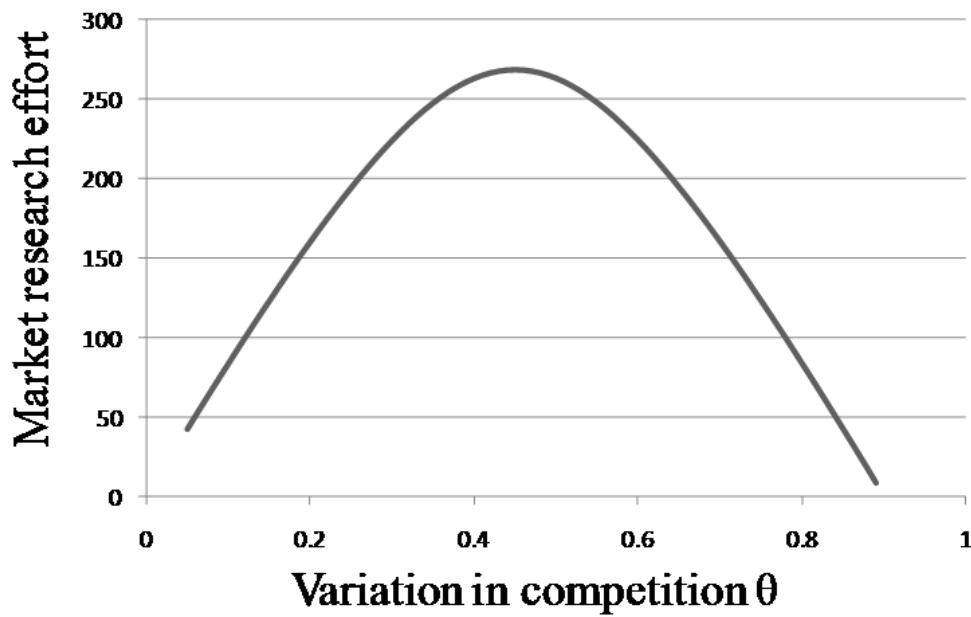


Figure 4: The research effort of all firms as a function of θ . The following parameters are assumed: $m=1000$, $f=100$ and $r=0.05$. Parameters for which the parametric conditions are not fulfilled are excluded from the representation.

Figure 3.4: Figure 4

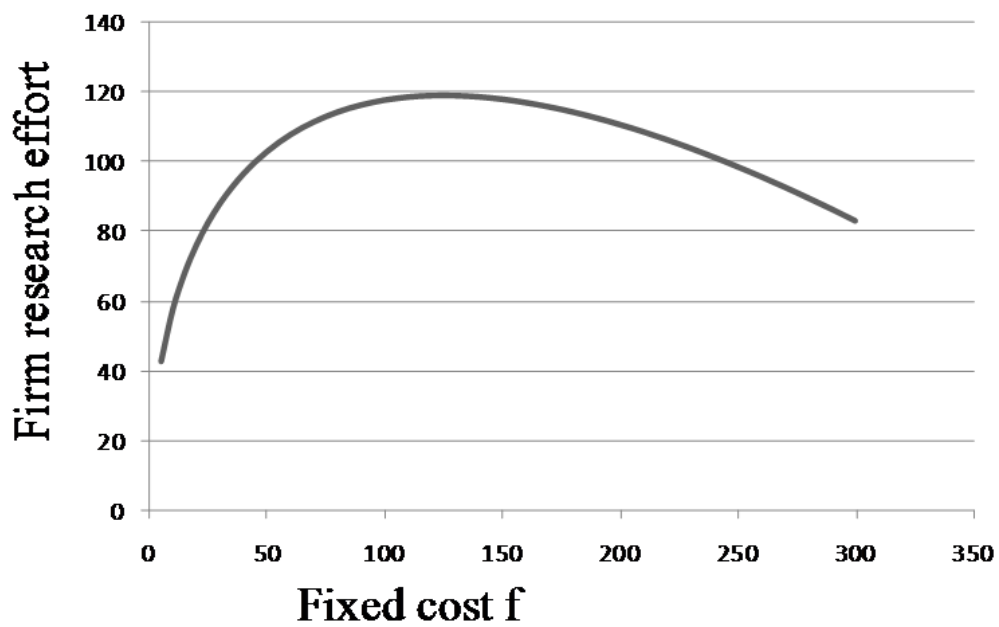


Figure 5: The research effort of one firm varying with fixed costs f . I is assumed to be 1000, r is 5 percent, θ is 0.5.

Figure 3.5: Figure 5

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Chapter 4

Determinants of survival of African exporters

This chapter was co-authored with Denisse Pierola (a consultant at World Bank PREM research department), Olivier Cadot (senior economist at the World Bank PREM) and Leonardo Iacovone (Young Professional at the World Bank, currently in the Africa department). It uses two novel datasets collected by PREM trade at the World Bank. I presented this part to the World Bank Africa department, and my co-workers presented it on several occasions to businessmen in Africa. In turn, its conclusion has been quoted in at least six African newspapers and two African TV channels.

4.1 Introduction

In their seminal work on export survival, Besedes and Prusa (2006a) showed that the median duration of export spells¹ was only two years. Besedes and Prusa's striking findings have both positive and normative implications.

From a positive perspective, they suggest that there are three, not two margins for export growth. Besides volumes (the 'intensive margin') and diversification (the 'extensive margin'—geographical or product-wise), the third and new margin is export survival (the 'sustainability margin'). From a normative perspective, they suggest, albeit indirectly, that targeting the sustainability margin may be particularly important if getting into export markets involves sunk costs (as suggested by the work of Das, Robert and Tybout 2007), because short survival spell imply repeated entry and hence duplication of sunk costs.

Moreover, Besedes and Prusa (2007) showed that cross-country variation in the extensive margin explains little of the variation in subsequent export growth because of the short average duration

¹Meaning periods during which U.S.-bound bilateral flows at a highly disaggregated product level went on without interruptions of more than one year.

of spells. By contrast, both the intensive margin and the sustainability margin matter substantially, suggesting that those should be the margins targeted by export promotion. It is thus important for the design of export-promotion policies to search for robust and potentially policy-related determinants of export survival. The present paper contributes to this search.

At the product level, the determinants of export survival have been explored by a small but growing literature. Besedes and Prusa (2006a) used two panels of U.S. imports, one spanning 1972-88 with tariff-schedule data, the other spanning the 1989-2001 period with 10-digit data (the Feenstra-NBER dataset). In both cases, they found that half of all trade relationships lasted only one year and three quarters lasted three years or less. Once censoring was taken into account, median duration was two years. Most strikingly, this pattern of short duration was robust to aggregation to HS6, even though one would expect interruptions to be smoothed out by aggregation. They also found negative duration dependence, meaning that the hazard rate fell as export spells grew older. This finding, however, has been recently contested by Brenton, Saborowsky and von Uexhull (2010).² In terms of survival determinants, Besedes and Prusa found that industrial-country exports lasted longer, and so did exports of machinery, a finding confirmed by the analysis of Asian trade flows by Obashi (2009).

Besedes and Prusa (2006b) dig deeper into the determinants of export survival by testing the implications of a search model proposed by Rauch and Watson (2003) in which importers search for low-cost suppliers and exporters invest optimally in production capacity in the face of moral hazard (risk of non-payment). The model implies that, in general, smaller initial transactions have a lower life expectancy; however, differentiated goods, where moral hazard is highest, involve both smaller initial transactions *and* longer life expectancy.

The model's predictions are upheld by Cox regressions on U.S. import data using Rauch's (1999) index of product differentiation as a regressor. That is, the hazard rate is 23% higher for homogenous products than for differentiated ones, although initial transactions are between 40% and 350% larger. In related work, Besedes (2008) also finds supports for the Rauch-Watson hypotheses on a restricted sample of Rauch-differentiated products where he proxies search costs by the number of potential suppliers and reliability by income levels.

Evidence from non-U.S. trade flows largely confirms the early findings. The determinants of export duration were explored by Nitsch (2009) using Cox regressions on a ten-year panel of German imports at the HS8 level. He found that gravity variables (distance, exporter GDP, common language, common border, etc.) influenced the duration of trade flows pretty much the same way they influenced trade volumes. Interestingly, he found that the short duration of trade flows held even when flows below 10'000 euros were excluded. Molina and Fugazza (2009) extended the exploration to a nine-year panel of HS6 bilateral trade flows between 96 countries using, as regressors, gravity variables and time

²Brenton et al. argue that the assumption of proportional hazards, which is needed for Cox regressions to be valid, typically does not hold in export-duration samples (this can be verified using a Schönfeld test). The alternative Prentice-Gloeckler (1978) estimator suggests no duration dependence. Brenton et al.'s critique applies to the quasi-entirety of the export-survival literature.

required for export procedures (based on the World Bank's *Doing Business* surveys) as proxies for fixed costs. Besides usual findings on the effect of gravity variables and income levels, they found that fixed costs reduce survival.³

A similar exercise was carried out on Asian trade flows by Obashi (2009) with largely convergent results. In particular, the 2-to-3 year median survival seems to hold across all samples studied. Obashi also found that vertical trade relationships (involving the sale of semi-finished product) have hazard rates one-third lower than those involving the sale of final goods, and that they are less sensitive to trade costs (e.g. distance or exchange-rate fluctuations).

A smaller number of recent papers have made use of the growing availability of firm-level datasets to shed new light on the determinants of export survival. Moving from the product to the firm level makes it possible to enlarge the set of those determinants in a way that may help understand how export-promotion agencies, for instance, help overcome market failures. Export promotion at the national level contributes, by exploiting economies of scale in the production of information, to overcome imperfect exporter information on destination-market demand and requirements. It may also leverage synergies between national exporters to create national brand name'. In some well-known cases, the national brand name is sufficiently visible that State-led promotion is not, or no longer, necessary (Columbian coffee, Thai rice, Chilean wines to name but a few). In other cases, provided that synergies do exist, State intervention can help facilitate exporter coordination and make use of existing diplomatic representations (Rose). Gorg et al. (2008) test the implications of the heterogeneous-firm model of Bernard et al. (2006) on a rich panel of 2,043 Hungarian firms spanning the transition from centrally-planned to market economy (1992-2003). The data contains exports at the firm-HS6 level as well as firm characteristics. They find large product turnover during the period as firms constantly rearrange their product portfolios. They also find longer survival for products located close to the firm's core competencies and to the country's comparative advantage. These results are consistent with the results of Iacovone and Javorcik (2010) showing the importance of churning at firm-level in responses to exogenous opportunities provided by increasing globalization.

Alvarez and López (2008) used Tobit regressions to study the determinants of industry-level rates of entry and exit into exporting using a 10-year panel of 5'000 Chilean plants. They found that within-industry heterogeneity, measured (inter alia) by the dispersion of firm-level productivity levels, played an important role in explaining firm turnover in and out of exporting.

By contrast, trade costs, factor intensities, and exchange-rate fluctuations were found to have only marginal impacts. Carballo and Volpe (2008) used a 6-year panel of firm-level Peruvian exports at the HS10 level to explore how diversification strategies (in terms of products and markets) affect the survival of firm-level exporting activity. They found that both geographical and product-wise diversification raised survival, but geographical diversification more so—presumably because it proxies

³This is unintuitive: in microeconomics, the shut-down point depends on average *variable* costs, not on fixed costs. However the fixed export costs they consider are incurred for each transaction, although they do not depend on transaction size. They are therefore not really fixed when looking at flows aggregated to the annual level.

for product quality.

We build on this literature and use transaction-level data obtained directly from customs in a sample of African countries (Malawi, Mali, Senegal and Tanzania) to revisit the issue of export survival at the firm level. Our sample of countries is selected essentially on the basis of data availability and reliability.⁴

In particular, we focus on the determinants of survival beyond the first year. In spite of the noisy data, we find strikingly robust results across our sample of four countries. Synergy effects, positive spillovers due to the existence of other firms exporting the same product to the same destination, are significant at the 1% level in all four countries, as are scale/experience effects. For a Senegalese exporter, for instance, the 2001 first-year average survival probability of 22% would rise by eight percentage points to 30% if the number of national competitors selling the same HS6 product on the same destination market were to double from the baseline 21 to 42. Moreover, results on a pooled sample including all four countries suggest that the synergies are truly national. We test this by testing the significance of a “placebo” synergy effecting proxied by the number of other firms exporting the same product to the same destination but in other countries (for Senegal we use Malawi, Mali and Tanzania). Consistently with our expectations, this placebo effect is not significant. Thus, it is really the mass of exporters from the same country that influences the survival probability and not the mass of exporters of other countries.

Our results help explain a finding highlighted in Easterly, Resheff and Shenkenberg (2009); namely, that national export success often takes the form of ‘big hits’, with one narrow export item suddenly growing rapidly. If a sufficient number of exporters target one market simultaneously, their chances of surviving are larger, possibly triggering a virtuous cycle of survival and growth (like for example Eaton et al. (2008) we find that export spells that survive tend to grow—for instance, in Senegal, products that entered a market in 2001 and survived till 2008 reached, by then, four times their entry volume). From a normative viewpoint, our results provide a rationale for using public funds to promote national exports abroad. The positive synergy we identify is akin to external economies of scale, as the presence of same country-same product competitors means that each exporter can expect to amortize market entry costs over longer sales runs. However, these economies of scale are unlikely to be sufficiently visible and understood to induce incumbent exporters to provide assistance to entrants (something that is seldom seen in reality), leading to a market failure. Public intervention in the form of export promotion or provision of key complementary inputs could help overcome this market failure.

Another important result is related to the importance of “experience” or “quality” of a firm’s products. The “experience” with a market is proxied by the number of products that a firm exports already to a certain market. Instead, the “experience” with a product is proxied by the number of destinations to which this product is exported, the latter is also a potential proxy for the quality of a firm’s product and its “brand” across multiple markets. Both the experience with a market and the experience with a product significantly increase the probability of survival beyond the first year.

⁴The data must of course be taken cautiously, as export transactions are imperfectly monitored by customs (exports typically bring no revenue) and African customs suffer from weak statistical capabilities.

The paper is organized as follows: Section 2 presents a few stylized facts using a recent survey of African exporters conducted by the World Bank as part of the African exporter survival project. Section 3 describes the data. Section 4 discusses estimation issues and results, and section 5 concludes.

4.2 Data

We use raw transaction-level files from customs in the four countries covered. Each file contains information on products exported at the highest level of disaggregation used at the national level: 10-digit (Mali and Senegal) and 8-digit (Malawi and Tanzania) HS Code. For the purpose of our analysis, we aggregated the product information at the 6-digit level which is the standard used in comparisons across countries. In addition to the product information, each file contains information on FOB destination market, shipment value, net weight involved in the transaction, exporting firm's name, port and date of transaction. In the cases where it was possible to identify, we have filtered out years that had different coverage in terms of the ports included. For instance, in the case of Malawi, we have information from 2004, however, the number of ports covered was significantly smaller than the number of ports covered from 2005 onwards, therefore, we excluded such information from our analysis. Sample periods are 2005-2008 for Malawi, 2005-2008 for Mali, 2000-2008 for Senegal, and 2003-2008 for Tanzania.

Table 4.1 gives descriptive statistics. Tanzania has the largest number of firms (1'359), followed by Malawi (856), Senegal (715), and mali (280). Of course, all of those firms are, by construction, exporting firms, so the decision to export is outside the paper's scope, and all our results must be understood as conditional on beginning to export.

We aggregated transactions to *annual* (firm f destination d product⁵ p starting year y) quartets, our primary sample unit. Before turning to survival analysis (next section), a few observations can be made. Following the literature on the intensive and extensive margins (e.g. Evenett and Venables 2003 or Brenton and Newfarmer 2007), we group our primary sample units into new firms, new products, new destinations and continuing firm-product-destinations. Items labeled 'new' refer to units that are present in the data at time t but not at time $t - 1$.

These groups are designed to be mutually exclusive: If a new firm enters the export markets all the destinations to which it ships all its products are counted in the new firm' category. If an existing firm introduces a product, all destinations of that new product are counted in the 'new product' category. If an existing firm exports an existing product to a new destination, it is counted in the 'new destination' category. The remaining existing firm-product-destinations comprise the fourth category (of continuing firm product destination). The total change in the last of category is the intensive margin. Changes in the first three all contribute to the extensive margin.

Figure 4.1 shows observation counts and aggregate dollar values for the four categories of this decomposition in our four countries. Looking at export values, existing product sold in existing destinations

⁵Classified at HS 6 digits

(i.e. observations for which firm, destination and HS6 at time t are all the same as they were at time $t-1$) dominate in dollar value, although not always in count. For example, in Tanzania, continued firm-product-destinations accounted for 90 percent of export value in 2006 but only for 25% of the observation count. This suggests that our countries experiment substantially, consistently with the findings of Iacovone and Javorcik (2010) for Mexico and with the empirical observations of Cadot, Carrère and Strauss-Kahn (2010) on low-income countries. Continuing firm product destinations make up a relatively small number of export transactions, but a large share of export values. This confirms findings of Besedes and Prusa (2007) and Brenton and Newfarmer (2007), who also demonstrate the importance of the intensive margin in explaining export growth in developing countries (see also Evenett and Venables 2002).

We also find that a firm's product that manages to survive on a given destination market will grow in volume over time. Conditional on survival, Senegalese firm-product-destinations that appear in 2001 (we don't know the initial year of those appearing in 2000, the sample's initial year, because they are censored) grew by a factor of more than four between 2001 and 2008. Similarly, Tanzanian firm-product-destinations that appear in 2005 grew by a factor of over three in the period under analysis (i.e. up to 2008).

Table 4.2 shows the number of firms, firm-products, and firm-product-destinations by year of entry, and tracks their survival over time for each origin country. Naturally, these numbers decrease because of attrition. What is remarkable however is how large is the attrition in the first year and how quickly it decreases through time. For instance, looking at the Senegal panel, of the 206 firms that entered the export markets in 2001, 84 were still alive in 2002, and only 21 in 2008 (from 24 in 2007).

The third column of that table is derived from the second and shows the survival rate with respect to the previous year over time (i.e. one minus the annual death rate). Survival rates increase over time. For instance, 59 percent of firms that entered in 2001 dropped out until the next year, while 13 percent of firms that survived until 2007 survive also until 2008.

This casual observation is consistent with Besedes and Prusa's decreasing-hazard rate finding (annual death rates are discrete-time approximations to instantaneous hazard rates) although, as noted, this finding must be taken cautiously. Comparing the upper panel (firms) with middle and lower ones (products and product-destinations respectively) shows that there is less stability at more 'disaggregate' levels. These results suggest that there is churning in export products and destinations *within* firms; in other words, that firms experiment with products and destinations. Thus, Hausman and Rodrik's self-discovery process holds not only at the national level, but also—quite naturally—at the firm level (Hausman and Rodrik 2003). This pattern is also consistent with the notion that firms face uncertainty about export costs or demand parameters, a notion that is central to the heterogeneous-firms literature.

The fourth column shows survival rates with respect to the first year. While 90 percent of the firms that entered in 2001 drop out until 2008, 97 percent of firm-products and 97 percent of firm-product-destinations are no longer present.

In all four countries, the exit rate in the first year is very high. Low survival rates suggest that not only the study of new entry to export markets is an important determinant of exports, but also that the survival rates in the first year play a crucial role in the determination of sustained export flows, and might be an important angle to improve in order to generate stable export flows. For this reason in the next section we study carefully the determinants of survival in the first year.

4.3 Estimation strategy

After aggregation of transactions to cumulated annual totals, the primary sample remains a panel, as we observe repeated firm f destination d product p triplets over several years. However we are interested in the survival in the first, so the data needs to undertake a second transformation. We define a new (firm f destination d product p initial year y) quartet as one that appears for the first time in the database, and say that this quartet ‘survives’ if it lasts more than one year. The quartet is then associated to a survival dummy (our dependent variable) equal to one. If it lasts only one year, it is associated with a survival dummy equal to zero. If it has already appeared in the sample, we drop it (this concerns only a very small number of observations, since our sample periods are only a few years except for Senegal). Thus, we reduce our panel to a quasi-cross-section, even though each observation has an initial-year tag allowing us to control for calendar time. Doing so allows us to bypass the issue of how long a spell break should be to be considered a ‘death’, an issue that has been discussed at length in the survival literature and that has no clear-cut answer. Unless indicated otherwise, all our regressions are run separately by country.

Formally, let $v_{fpd,t}$ be the dollar value of exports, by firm f , of product p to destination d in calendar year t . We ignore exporting-country subscripts since our equation is estimated at the country level. Our dependent variable is

$$s_{fpd,t} = \begin{cases} 1 & \text{if } s_{fpd,t} > 0, s_{fpd,t-n} = 0, \text{ and } s_{fpd,t+1} > 0 \\ 0 & \text{otherwise} \end{cases} \quad (4.1)$$

for all $n > 0$, and the estimating equation is

$$\Pr(s_{fpd,t} = 1) = \phi(\mathbf{X}_{fpd,t}\beta + \delta_i + \delta_d + \delta_t + u_{fpd,t}) \quad (4.2)$$

where ϕ is the probit function and i indexes industries (HS2). $\mathbf{X}_{fpd,t}$ is a vector of regressors. It includes measures of the firm’s experience with the product and with the destination as well as proxies for agglomeration and market attractiveness. These proxies are counts of (i) n_{ft} , the number of other products exported by firm f ; (ii) $n_{fd,t}$, the number of products that firm f exports to the same destination d ; (iii) $n_{pd,t}$, the number of firms that export the same product p to the same destination d ; and (iv) n_{dt} , the total number of products exported to destination d by all firms from the same country. That is, the notation convention is to omit the index of the dimension over which the count

is summed. All counts are put in logs, and all regressions include time fixed effects δ_t , destination fixed effects δ_d , and industry (HS2) fixed effects δ_i . We use robust standard errors clustered at the product-destination level throughout.

This Our second outcome of interest is the log value at which units enter the export markets. The equation we estimate is

$$\ln v_{fpt} = X_{fpt}\beta + \delta_f + \delta_d + \delta_t + u_{fpt} \quad (4.3)$$

where v_{fpt} is the value of product p by firm f shipped to destination d at time t in the export spell's initial year.

We estimate 4.2 by probit (reporting marginal effects) and 4.3 by OLS. Typically, marginal effects of a probit estimation can be interpreted like OLS coefficient, and also in the present case a robustness check reveals that quantitatively the difference between the results from an OLS and a probit regression are small and in most cases not statistically significant.⁶

4.4 Results

Baseline regression results are shown in table 4.3. The first regressor of interest is $\ln n_{dt}$, the number of national (firm f product p) combinations sold on a given destination market. If one Senegalese firm sells two HS6 products in the E.U. and another one sells three, $n_{dt} = 5$ for all five observations with $d = \text{E.U.}$ in year t . The effect of this count on survival is negative and significant. Given that we apply destination fixed effects, this variable picks up time-variant destination-country effects, like growth booms in the destination market. If demand shocks at the national market/HS6 level follow, over time, a mean-reverting process with low persistence, our finding has a natural interpretation—namely, that exporters enter booming markets and exit them when the boom is over, which our result suggests comes soon.⁷

The second variable reported in Table 4.3, $\ln n_{pdt}$, counts the number of firms selling the same product in the same destination. This picks up synergy or agglomeration effects. We find that the effect is, again, statistically significant. Ignoring the count nature of the variable, we can approximate its quantitative effect by writing the probability of survival as $p_{fpt} = \Pr(s_{fpt} = 1)$, so that, using the first column of Table 4.3,

$$dP_{fpt} = 0.0792d \ln n_{pdt} = 0.0792d \frac{dn_{pdt}}{n_{pdt}} \quad (4.4)$$

⁶Results of a comparison of OLS and Probit estimates are available upon request.

⁷If we rerun the exercise without destination fixed effects, the coefficient on this variable turns positive in explaining survival, suggesting that *permanently* more attractive markets are associated with longer survival, which is consistent with our interpretation.

Using $p_{f\text{pdt}} = 0.22$ (from the lower panel of 4.2) and $n_{\text{pdt}} = 22$ as initial values, a doubling of the number of exporters ($dn_{\text{pdt}}/n_{\text{pdt}} = 1$) gives $dp_{f\text{pdt}} = 0.0792$ or about 8 percentage points more in the probability of survival beyond the first year.

Thirdly we measure the experience of a firm with the product by counting the number of destinations where the firm exports this product to ($\lnnr_sf_sp_d$). Experience with a product increases the value of first year exports significantly, and also increases the survival probability in all regressions we tested. This suggest that firms which export to more market may have more information about a certain product and its demand, therefore become able at making better choices for additional destinations and are more confident about their entry, which is reflected in the higher values with which they enter. An alternative interpretation, from a supply perspective, would suggest that the number of markets served by a firm with a specific product capture the quality of the product and therefore firms producing better products (or “more sought after”) are able to enter new markets more confidently that they will be successful, with larger initial values, and indeed end up being more likely to survive beyond the first year.

Finally we measure firm experience with a certain destination by counting the number of products that the same firm exports to that destination ($\lnnr_sf_p_sd$). We find that in Tanzania, Senegal and Malawi such experience increases the survival probability significantly, while in Malawi the effect is not significantly different from zero. The value of first year exports is significantly lower in all four countries. Thus experience with a destination gives firms the confidence to export also goods at lower quantities, while the survival probability of these goods is higher.⁸ A possible interpretation of this result is that there are separate, and different, fixed costs to enter a new market and to start exporting a new product. Once, a firm has already incurred in the market-specific fixed costs, introducing new products becomes easier and the firm is willing to experiment more, starting smaller, in search of new market opportunities. Similarly, the knowledge of the market, makes it easier to identify those market opportunities and increases the chances of survival.

It should be stressed that since all these four effects are present in a single regression, the results are conditional on each other. Further, given the specification, all results must be interpreted conditional on entry to export in the year for which the equation is estimated.

Further we reproduce one stylized fact from the literature in table 4.6, namely that exports with higher values are more likely to survive the first year. This might reflect exporters that are more confident about their products enter the export markets with higher quantities in the first year, and that confidence is positively correlated with actual survival. In all four of our regressions this is significantly observed, while all other results remain similar in terms of size and significance.

Given the data at hand, we do not have many variables to control for firm heterogeneity. In principle this may effect our results by the inclusion of an omitted variable bias. For this reason we recompute the results and add a firm fixed effect that eliminates time-invariant firm heterogeneity, such as management ability. Table 4.7 reports these results, and shows that the results described are robust to

⁸Note that in terms of impact the experience with a product differs from experience with a destination.

the inclusion of firm fixed effects, in sign, size and significance.⁹

As a robustness check to these findings, we recompute the table using lagged explaining variables in table 4.4. While some coefficients slightly differ in their level of significance between these two tables, all coefficients that are significantly different from zero show the same signs in both tables, and generally the results are qualitatively similar.

Another concern is that a large fraction of exports might be from NGOs, international organizations or embassies. Since exports from these institutions are typically not driven by profit motives, they might bias our results. The data for one of the countries considered (Senegal) allows us to distinguish types of exporters, and to recompute the results excluding these international exporters. Table 4.5 displays this robustness check, and shows that the results hold in a similar way if these exporters are excluded. In terms of observations, these “non private” exporters constitute less than three percent of total exports.

We also analyze how the results affect different products differently. First we construct a measure of revealed comparative advantage of product i defined as

$$rca_i = \frac{\frac{x_{ic}}{\sum_i x_{ic}}}{\frac{x_{iw}}{\sum_i x_{iw}}} \quad (4.5)$$

In this equation x_{ic} denotes the export of good i of country c and x_{iw} the export of good i of the world. Thus this coefficient measures the ratio of the share of the export of a certain good in a country’s total exports to the share of the export of that good in global exports. The higher its value, the more that country is believed to have a comparative advantage for the production of that good. To compute this time invariant measure we use the mean of exports of the years 1999, 2000 and 2001. This variable measures differences of endowments of natural resources and infrastructure that favors the production or export of particular goods. As displayed in table 4.8, we find some evidence that goods for which a country has a higher revealed comparative advantage have a higher survival probability and enter at higher values to the export markets. The results presented previously do not change once we include this control for comparative advantage. This is particularly important for our agglomeration effect as this could capture also comparative advantage. Instead, these results suggest that this agglomeration or synergy effect goes beyond comparative advantage differences and can be more clearly interpreted in terms of knowledge spillovers or information flows.

In table 4.11 we test if the results are different for homogeneous and heterogeneous products as classified by Rauch (1999).¹⁰ We find that consistently across the four countries the negative impact of market attractiveness on survival is stronger for homogeneous goods. These goods are less differentiable and thus more exposed to tougher competition. The agglomeration effect is not consistently stronger across

⁹For computational purposes in this table the survival columns are not estimated by a marginal-effects probit strategy, but with the help of OLS. Since we found for estimations as in table 4.3 that the marginal effects for the survival probability estimated by probit do not differ much from OLS we think that this is a valid approximation also here.

¹⁰We treat goods classified as reference price goods similar to homogeneous goods.

countries for homogeneous or heterogeneous goods. Both experience effects however are stronger for heterogeneous goods, consistently with the idea that these products benefit more from additional access to information about demand, both market-specific and product-specific.

In the literature it has been suggested that firms have core and marginal products, and that firms have a higher comparative advantage in the production of their core products (see for example Eckel and Neary (2010) for a theoretical model and Iacovone, Rauch and Winters (2010) for an empirical test of this). To test if this result holds also, we use the variation of firms that enter with several products simultaneously, and compute the share of each of these products within the total value of all entrants. This variable (*prod.share*) must be between zero and one. In the first four columns of table 4.12 we repeat our standard estimation. The table suggests that this share is indeed positively correlated with size and survival probability of entrants, which is analogue to the results provided in table 4.6. However, this effect as in the first four columns could be solely mechanical, since we established that firm-product-destinations with long survival have a high survival probability and also a large value. This pattern emerges also when controlling for size of entry, which highlights the importance of core products also on export markets.

Another robustness check concerns the “agglomeration effect”. We find that this effect disappears when we replace the agglomeration effect with a “placebo agglomeration”, which denotes the same measure for each product as the mean or the value from the other three countries (see table 4.13). Since these effects are positively correlated for products across countries, we control for comparative advantage and firm fixed effects in this table.

Finally, the export data provided by the African customs authorities for each of the African countries studied does not always fit the global imports reported from this country by other sources (Comtrade). Noise may have been introduced for example by the authorities reporting either measure or by different exchange rates used for conversion. In table 4.9 we repeat the estimation only for those sectors, where the sum of export value reported by our destination countries for a product is closer than 10 percent to the value reported by Comtrade. As apparent from the table, while the number of observation shrinks, the results do not change.

4.5 Qualitative evidence from a survey

The previous results highlight some determinants of survival of discoveries on export markets. To understand the nature of these effects better and to complement these findings, we present in this section, some of the results from the survey of exporters on Export Survival conducted by the International Trade Department of the World Bank in 2009 in the four countries included in our analysis (See Annex 1 for more background information on this survey).

The questionnaire applied in this survey contained three sections; one on basic information of the firm, another covering constraints to survival and a third one on perception of opportunities and plans for expansion in the future. The second section of the questionnaire which addresses specific constraints

to survival and to exporting in general also covers the role of networks in the contact with clients. The answers to the questions related to this latter aspect and which support the findings presented in the previous section are provided in Table 4.10.¹¹

The first question investigates how exporters made contact with their first client the very first time they engaged in an exporting transaction. The answer that dominated largely was that third party contacts such as relatives, friends, intermediaries and suppliers provided most of the contacts. This is consistent with the positive effect from agglomeration that we find in the regression analysis, and might highlight one of the channels through which this effect operates. Overall, the second and third most important answers were research online and trade fairs. The latter could be one of the public goods related to agglomeration. Contacts also emerge through competitors' networks, export promotion agencies, exporters' associations and other channels, but to a lesser degree (with importance to less than a fifth of the first time exporters).

The second and third question address the role of networks in buyer-seller relations other than the first one and asked how the contact is made when the company looks for buyers (Question 2) and how it is made when it is the buyer who looks for the company (Question 3). First, regarding Question 2, we find again that the leading answer given was "through third party contacts (such as suppliers, intermediaries, friends, relatives, ...)", which played an important role for 70 percent of the respondent exporters. Also the other channels were given more importance than in the first questions, with slight differences of ranking. Trade fairs played an importance for 39 percent of the responding firms, while export promotion agencies for only 17 percent.

Question 3 enquires the channels normally used by buyers to contact exporters themselves. We find again that third party contacts play the main role with 70 percent relevance. Trade fairs and the information provided online through the company's website were again the second and third most chosen option with 35 and 33 percent of the responses respectively. However, they are closely followed by the option that indicates the importance of having a pre-established relationship between the company and the buyer (i.e. the client was an old client of the company), which takes 30 percent of the responses in this question. This highlights one effect through which the "experience" variable might operate. Competitors' networks, export promotion agencies and other channels were the least important answers.

Finally, Question 4 asks how the opportunity to export a new product came about in the first place. The most important answer points to the presence of existing buyers who approach the company and asks for other products. This highlights the importance of "experience" for the establishment of new export contacts. The second most important answer was that companies had success with products domestically and thus decided to offer them abroad. 46 percent of companies answered that they saw demand in an existing buyers' market, which again highlights to the importance of experience. Third parties and the imitation of successful competitors played minor roles.

¹¹The questions are designed such that each firm has multiple choices to select as a response, hence, the answers can sum to more than 100 percent.

4.6 Conclusion

We document for the set of African countries studied that these countries experiment a lot on export markets on low scale and with low survival rates, particularly in the first year on export markets. Thus the focus of this paper lies in the analysis of the determinants of the first year survival probability of new entrants to export markets. In addition we study the size at which different products enter.

We find that experience of firms with either a destination or a product increases the survival probability of its new entry experiments greatly. Firms that have experience with a certain destination are able to export low-quantity products with better survival probabilities there, while firms that have experience with a product export higher quantities with increased survival probabilities. Agglomeration – the joint export of a certain good by many different firms to the same destination – also has a positive effect on survival. We present evidence from a survey that in part this agglomeration effect may be due to information gains. However we recognize this may not be the only channel, consistently with recent work by Hausmann and his co-authors (Hausmann and Klinger 2006, Hausman 2008), the synergy effect may be also capturing the fact that a country is endowed with specific production capabilities and a new exporter relying on this country-product specific capabilities become significantly more likely to survive beyond the first year.

Finally we show that booms to certain destinations attract relatively small exports and typically have bad survival rates.

Experience is more helpful for heterogeneous goods, which suggests the importance of information uncertainties. Further, the results are robust to the inclusion of controls of comparative advantage.

Our results suggest that policies have different effects for different types of firms. The political goal to achieve more sustainable export links can be more easily reached in cooperation with experienced exporters (while the experimentation of unexperienced firms might serve to discover new export possibilities). Further we highlight positive spillovers from established exporters on newcomers, and potentially the importance of accumulating product-specific production capabilities.

4.7 Appendix 1

This survey was conducted over a sample of exporters randomly drawn from the customs data in each country, after applying some pre-established guidelines that took into account the following criteria:

- exporting status of the firm,
- its size,
- its location

- the economic sector (at the 2-digit level of the HS Code)

In particular, all the exporters in each country were classified in four groups according to the evolution of their exporting status: a) regular exporters are those exporters with consecutive exports until 2008 (last year covered by the customs data in all four countries), b) past exporters are the exporters who were exporting consecutively for at least two years and then exited the market before 2008, c) intermittent exporters are those who exported erratically during the period included in the sample and finally, d) new exporters are those exporters who appear for the first time in the sample in 2008.

Over 200 firms were contacted in each country; however, due to low cooperation and identification problems with some of the firms, the final sample by country and exporting group is as follows:

Country	Intermit	New	Reg	Past	Total
Gha	6	4	66	37	113
Mwi	9	13	54	15	91
Mli	12	18	48	20	98
Sen	29	24	39	32	124
Tza	22	8	38	16	84
Total	78	67	245	120	510

	Nr firms	Nr prod.	Nr dest.	Nr prod/firm		Nr dest/firm		Nr firms/prod		Nr firms/dest		Value of entry (USD)	
				Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Mali	280	575	99	2.54	2	3.89	2	1.89	1	7.18	2	219,694	5,373
Malawi	856	932	102	1.57	1	4.10	2	3.76	1	13.19	3	106,475	571
Senegal	715	1,653	100	3.10	1	6.76	2	2.92	2	22.17	5	47,111	3,446
Tanzania	1,359	1,689	137	2.49	1	3.62	1	2.91	1	24.69	7	83,078	2,858

Table 4.1: Descriptive statistics. This table shows for each source country: The number of firms, products, destinations, the number of products per firm, number of destination per firm, number of firms per product, number of firms per destination and the value of those firms that entered the export market. All values are computed for the year 2006.

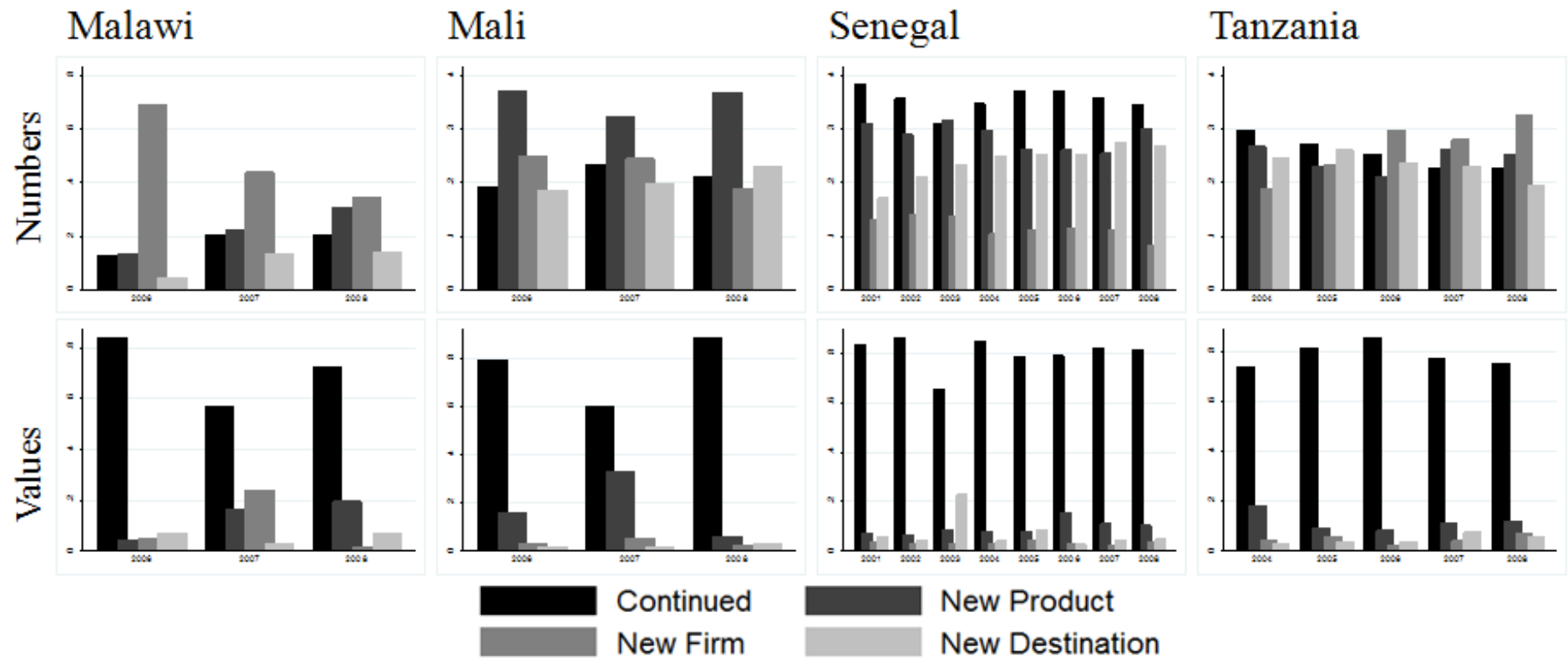


Figure 4.1: This graph classifies each of the origin-firm-product-destination observations into one of four mutually exclusive groups: *New Destination* includes units of existing firms which export an existing product to a new destination; *New Products* includes existing firms that add a product to their portfolio, *New Firms* includes all units from firms that did not export before, while *Continued* includes all other units. The first set of graphs displays the share of observations, and the second set the share of total values of each category.

		Senegal		Tanzania			Mali			Malawi		
		Entry: 2001		Entry: 2004			Entry: 2005			Entry: 2005		
	Nr	Y-Exit	Exit	Nr	Y-Exit	Exit	Nr	Y-Exit	Exit	Nr	Y-Exit	Exit
Firm												
2001	206											
2002	84	0.59	0.59									
2003	57	0.32	0.72									
2004	40	0.30	0.81	420								
2005	35	0.13	0.83	194	0.54	0.54	273			670		
2006	29	0.17	0.86	118	0.39	0.72	159	0.42	0.42	217	0.68	0.68
2007	24	0.17	0.88	85	0.28	0.80	123	0.23	0.55	154	0.29	0.77
2008	21	0.13	0.90	75	0.12	0.82	103	0.16	0.62	126	0.18	0.81
Product												
2001	2055											
2002	449	0.78	0.78									
2003	192	0.57	0.91									
2004	117	0.39	0.94	2656								
2005	94	0.20	0.95	497	0.81	0.81	1047			3322		
2006	78	0.17	0.96	200	0.60	0.92	305	0.71	0.71	325	0.90	0.90
2007	61	0.22	0.97	106	0.47	0.96	166	0.46	0.84	174	0.46	0.95
2008	54	0.11	0.97	71	0.33	0.97	123	0.26	0.88	127	0.27	0.96
Product destinations												
2001	3326											
2002	718	0.78	0.78									
2003	356	0.50	0.89									
2004	245	0.31	0.93	4908								
2005	167	0.32	0.95	837	0.83	0.83	1391			3828		
2006	129	0.23	0.96	295	0.65	0.94	286	0.79	0.79	509	0.87	0.87
2007	101	0.22	0.97	167	0.43	0.97	122	0.57	0.91	316	0.38	0.92
2008	84	0.17	0.97	113	0.32	0.98	82	0.33	0.94	224	0.29	0.94

Table 4.2: Survival cohorts. In the columns indexed *Nr* we document for each origin country the number of firms products and destinations for the longest available time series. Column *Y-Exit* shows the exit rate (ie. the share of units that left) with respect to the first year, and column *Exit* the exit rate with respect to the entry year.

Table 4.3: Effects

	Survival	Value	Survival	Value	Survival	Value	Survival	Value
lnnr_f_p_sd	-0.0347*** (0.00981)	-0.238*** (0.0572)	-0.0485*** (0.0128)	-0.0712 (0.0527)	-0.0390** (0.0165)	0.148 (0.149)	-0.116* (0.0612)	0.0529 (0.256)
lnnr_f_sp_sd	0.0792*** (0.00432)	0.219*** (0.0353)	0.0731*** (0.00459)	0.289*** (0.0261)	0.0125*** (0.00441)	0.193*** (0.0451)	0.108*** (0.0183)	0.452*** (0.120)
lnnr_sf_sp_d	0.124*** (0.00420)	0.686*** (0.0277)	0.197*** (0.00446)	0.405*** (0.0199)	0.102*** (0.00912)	1.302*** (0.102)	0.121*** (0.0180)	0.547*** (0.0956)
lnnr_sf_p_sd	0.0165*** (0.00228)	-0.387*** (0.0136)	0.0469*** (0.00271)	-0.467*** (0.0124)	0.00316 (0.00353)	-0.457*** (0.0382)	0.0409*** (0.0120)	-0.457*** (0.0610)
Observations	20380	20703	27135	27473	4938	5659	1954	2324

Note: Year, destination and industry (HS-2) fixed effects used. Robust standard errors are clustered on the level of product-destinations.

Table 4.4: Lagged rhs variables

	Tanzania		Senegal		Malawi		Mali	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Survival	Value	Survival	Value	Survival	Value	Survival	Value
Llnnr_f_p_sd	-0.0517*** (0.00676)	-0.183*** (0.0448)	-0.0276** (0.0123)	-0.0329 (0.0492)	0.00613 (0.0166)	-0.0739 (0.118)	0.0647 (0.0417)	-0.0643 (0.210)
Llnnr_f_sp_sd	0.0564*** (0.00488)	0.244*** (0.0370)	0.0616*** (0.00496)	0.327*** (0.0271)	0.0127*** (0.00472)	0.234*** (0.0428)	0.0988*** (0.0221)	0.436*** (0.125)
Llnnr_sf_sp_d	0.0706*** (0.00443)	0.428*** (0.0296)	0.143*** (0.00505)	0.352*** (0.0230)	0.0694*** (0.00899)	0.799*** (0.111)	0.171*** (0.0228)	0.796*** (0.124)
Llnnr_sf_p_sd	0.0131*** (0.00222)	-0.132*** (0.0130)	0.0216*** (0.00244)	-0.227*** (0.0116)	0.0234*** (0.00434)	-0.0569 (0.0477)	0.0169 (0.0130)	-0.251*** (0.0667)
Observations	20380	20703	27135	27473	4938	5659	1954	2324

Note: Year, destination and industry (HS-2) fixed effects used. Robust standard errors are clustered on the level of product-destinations.

Table 4.5: Robustness check: NGO

	Including IOs		Excluding IOs	
	(1)	(2)	(3)	(4)
	Survival	Value	Survival	Value
lnnr_f_p_sd	-0.0276** (0.0123)	-0.0329 (0.0492)	-0.0249** (0.0126)	-0.0280 (0.0502)
lnnr_f_sp_sd	0.0616*** (0.00496)	0.327*** (0.0271)	0.0614*** (0.00505)	0.329*** (0.0274)
lnnr_sf_sp_d	0.143*** (0.00505)	0.352*** (0.0230)	0.143*** (0.00517)	0.380*** (0.0235)
lnnr_sf_p_sd	0.0216*** (0.00244)	-0.227*** (0.0116)	0.0218*** (0.00247)	-0.229*** (0.0117)
Observations	27135	27473	26427	26760

Note: Year, destination and industry (HS-2) fixed effects used. Robust standard errors are clustered on the level of product-destinations.

Table 4.6: Values

	(1)	(2)	(3)	(4)
	survival	survival	survival	survival
lnnr_f_p_sd	-0.0252*** (0.00946)	-0.0456*** (0.0128)	-0.0320** (0.0159)	-0.119* (0.0609)
lnnr_f_sp_sd	0.0705*** (0.00412)	0.0658*** (0.00457)	0.00946** (0.00416)	0.0902*** (0.0179)
lnnr_sf_sp_d	0.101*** (0.00414)	0.186*** (0.00447)	0.0758*** (0.00850)	0.102*** (0.0179)
lnnr_sf_p_sd	0.0288*** (0.00225)	0.0608*** (0.00280)	0.0111*** (0.00338)	0.0552*** (0.0123)
ln_value	0.0335*** (0.00133)	0.0296*** (0.00149)	0.0153*** (0.00161)	0.0354*** (0.00491)
Observations	20380	27135	4938	1954

Note: Year, destination and industry (HS-2) fixed effects used. Robust standard errors are clustered on the level of product-destinations.

Table 4.7: Firm fixed effects

	Tanzania		Senegal		Malawi		Mali	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Survival	Value	Survival	Value	Survival	Value	Survival	Value
lnnr_f_p_sd	-0.0407*** (0.0114)	-0.240*** (0.0585)	-0.0397*** (0.0115)	-0.0640 (0.0537)	-0.0216 (0.0456)	0.386 (0.259)	-0.116** (0.0563)	0.0900 (0.299)
lnnr_f_sp_sd	0.105*** (0.00527)	0.300*** (0.0298)	0.0868*** (0.00470)	0.321*** (0.0254)	0.0398*** (0.00688)	0.323*** (0.0416)	0.0986*** (0.0227)	0.524*** (0.135)
lnnr_sf_sp_d	0.126*** (0.00600)	0.436*** (0.0302)	0.162*** (0.00546)	0.346*** (0.0241)	0.173*** (0.0257)	0.705*** (0.130)	0.106*** (0.0236)	0.474*** (0.123)
lnnr_sf_p_sd	0.0442*** (0.00424)	-0.142*** (0.0253)	0.0242*** (0.00359)	-0.369*** (0.0178)	0.0175 (0.0167)	-0.638*** (0.116)	0.0516*** (0.0168)	-0.207** (0.0935)
Constant	0.153** (0.0706)	8.451*** (0.604)	0.623 (0.432)	10.12*** (0.267)	-0.579* (0.302)	1.530 (0.934)	-0.00567 (0.269)	3.135** (1.314)
Observations	20703	20703	27473	27473	5659	5659	2324	2324

Note: Year, destination and industry (HS-2) fixed effects used. Robust standard errors are clustered on the level of product-destinations.

Table 4.8: Revealed comparative advantage

	Tanzania		Senegal		Malawi		Mali	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Survival	Value	Survival	Value	Survival	Value	Survival	Value
lnnr_f_p_sd	-0.0508*** (0.00748)	-0.168*** (0.0484)	-0.0335** (0.0133)	-0.00609 (0.0535)	0.0141 (0.0207)	-0.110 (0.123)	0.0282 (0.0545)	-0.0906 (0.243)
lnnr_f_sp_sd	0.0561*** (0.00530)	0.213*** (0.0378)	0.0664*** (0.00500)	0.308*** (0.0281)	0.0104* (0.00583)	0.188*** (0.0484)	0.0849*** (0.0279)	0.542*** (0.138)
lnnr_sf_sp_d	0.0710*** (0.00487)	0.387*** (0.0312)	0.152*** (0.00548)	0.405*** (0.0252)	0.0692*** (0.0101)	0.623*** (0.109)	0.174*** (0.0299)	0.618*** (0.149)
lnnr_sf_p_sd	0.0162*** (0.00254)	-0.127*** (0.0147)	0.0222*** (0.00261)	-0.229*** (0.0125)	0.0287*** (0.00568)	-0.0710 (0.0584)	0.0295* (0.0161)	-0.292*** (0.0858)
Comp. adv	0.00371** (0.00152)	0.0749*** (0.0104)	0.00132 (0.00164)	0.0872*** (0.00913)	0.00349* (0.00192)	0.0916*** (0.0191)	0.00663 (0.00648)	0.101*** (0.0351)
Observations	17078	17393	22748	23032	3668	4151	1277	1537

Note: Year, destination and industry (HS-2) fixed effects used. Robust standard errors are clustered on the level of product-destinations.

Table 4.9: Robustness: Consistent data only

	Tanzania		Senegal		Malawi		Mali	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	survival	ln_value	survival	ln_value	survival	ln_value	survival	ln_value
lnnr_f_p_sd	-0.0552*** (0.0134)	-0.312*** (0.0786)	-0.0402** (0.0166)	0.0512 (0.0663)	-0.0340 (0.0278)	0.0385 (0.177)	0.0634 (0.113)	-0.273 (0.512)
lnnr_f_sp_sd	0.0838*** (0.00534)	0.163*** (0.0428)	0.0626*** (0.00592)	0.220*** (0.0331)	0.0101 (0.00767)	0.122* (0.0649)	0.128** (0.0614)	0.101 (0.307)
lnnr_sf_sp_d	0.121*** (0.00511)	0.534*** (0.0337)	0.208*** (0.00541)	0.416*** (0.0237)	0.139*** (0.0164)	1.854*** (0.151)	0.0511 (0.0430)	0.0682 (0.218)
lnnr_sf_p_sd	0.00428 (0.00280)	-0.475*** (0.0169)	0.0423*** (0.00338)	-0.490*** (0.0150)	-0.00481 (0.00585)	-0.493*** (0.0516)	0.0415* (0.0223)	-0.438*** (0.129)
Observations	13370	13677	17197	17456	2362	3423	479	714

Note: Year, destination and industry (HS-2) fixed effects used. Robust standard errors are clustered on the level of product-destinations. This table only takes into account observations, where total exports from country are no more different than 10 percent from global imports reported by WITS.

Table 4.10: Survey

Question 1: First time exporters: How was the contact with the first client made?

	MLI	MWI	SEN	TZA	All
Research online	14	11	24	35	21
Third party contact ¹	73	68	77	51	67
Competitors' network	8	12	24	11	14
Trade Fair	20	12	19	34	21
Export Promotion Agency	12	11	5	13	10
Exporters' Association	9	7	8	8	8
Another channel	16	24	5	11	14

Question 2: If the company looked for its buyers, how did it approach them?

	MLI	MWI	SEN	TZA	All
Research online	26	31	29	41	32
Third party contact ¹	74	72	76	57	70
Competitors' network	19	18	23	21	20
Trade Fair	40	35	28	52	39
Export Promotion Agency	18	19	11	21	17
Exporters' Association	14	5	6	17	11
Another channel	10	20	15	6	13

Question 3: If the buyers approached the company, how did they approach it?

	MLI	MWI	SEN	TZA	All
Company's website	22	30	29	53	33
Old clients of the company	25	28	33	32	30
Third-party contact ¹	62	75	75	66	69
Competitors' network	14	28	21	26	22
Trade Fair	34	33	20	55	35
Export Promotion Agency	18	21	7	25	18
Another channel	9	22	15	8	13

Question 4: How did the opportunity to export a new product come about?

	MLI	MWI	SEN	TZA	All
An existing buyer approached the company	54	46	50	68	54
The company saw demand in a buyers' market	33	46	50	56	46
The company saw successful competitors	17	27	13	32	22
Success with selling the product domestically	38	42	44	68	48
Through a third party ¹	46	23	25	35	32
Any other type of opportunity?	17	19	13	6	14

¹ For example: suppliers, intermediates, friends, relatives, ...

Table 4.11: Rauch classification

	TZA		SEN		MLI		MWI	
	Hom	Het	Hom	Het	Hom	Het	Hom	Het
	survival	survival	survival	survival	survival	survival	survival	survival
lnnr_f_p_sd	-0.208*** (0.0543)	-0.176*** (0.0343)	-0.183** (0.0792)	-0.0835 (0.0544)	0.447 (0.309)	0.267 (0.269)	-0.00330 (0.202)	0.0406 (0.223)
lnnr_f_sp_sd	0.247*** (0.0302)	0.190*** (0.0317)	0.225*** (0.0264)	0.218*** (0.0214)	0.281** (0.117)	0.368*** (0.138)	0.204*** (0.0764)	0.0901* (0.0496)
lnnr_sf_sp_d	0.282*** (0.0271)	0.347*** (0.0278)	0.393*** (0.0292)	0.565*** (0.0228)	0.361** (0.146)	0.822*** (0.131)	0.484*** (0.0908)	0.894*** (0.173)
lnnr_sf_p_sd	0.0404*** (0.0145)	0.0589*** (0.0118)	0.0511*** (0.0169)	0.0836*** (0.00965)	-0.0887 (0.0864)	0.124** (0.0603)	0.0655 (0.0735)	0.221*** (0.0391)
Constant	0.0479 (1.043)	-0.499 (0.758)	0.358 (0.634)	0.543 (0.607)	1.184 (1.009)	-0.121 (1.294)	-0.145 (1.389)	0.183 (1.463)
Observations	6716	10934	7045	17238	568	967	826	3262

Note: Year, destination and industry (HS-2) fixed effects used. Robust standard errors are clustered on the level of product-destinations.

Table 4.12: Core products

	TZA	SEN	MWI	MLI	TZA	SEN	MWI	MLI
lnnr_f_p_sd	-0.0342*** (0.00960)	-0.0529*** (0.0128)	-0.0392** (0.0164)	-0.124** (0.0598)	-0.0257*** (0.00936)	-0.0485*** (0.0128)	-0.0321** (0.0159)	-0.122** (0.0603)
lnnr_f_sp_sd	0.0720*** (0.00421)	0.0708*** (0.00455)	0.0111** (0.00437)	0.0977*** (0.0180)	0.0671*** (0.00410)	0.0654*** (0.00456)	0.00913** (0.00416)	0.0874*** (0.0180)
lnnr_sf_sp_d	0.118*** (0.00418)	0.193*** (0.00445)	0.0994*** (0.00909)	0.111*** (0.0180)	0.0992*** (0.00414)	0.185*** (0.00447)	0.0755*** (0.00852)	0.0999*** (0.0179)
lnnr_sf_p_sd	0.0363*** (0.00265)	0.0661*** (0.00308)	0.0120*** (0.00457)	0.0881*** (0.0144)	0.0391*** (0.00259)	0.0701*** (0.00309)	0.0136*** (0.00421)	0.0813*** (0.0143)
prod_share	0.132*** (0.00923)	0.143*** (0.0107)	0.0380*** (0.0135)	0.209*** (0.0339)	0.0751*** (0.00924)	0.0813*** (0.0114)	0.0113 (0.0127)	0.130*** (0.0359)
ln_value					0.0310*** (0.00135)	0.0260*** (0.00158)	0.0150*** (0.00164)	0.0281*** (0.00514)
Observations	20380	27135	4938	1954	20380	27135	4938	1954

Note: Year, destination and industry (HS-2) fixed effects used. Robust standard errors are clustered on the level of product-destinations.

Table 4.13: Placebo agglomeration exercise

	(1) TZA	(2) SEN	(3) MWI	(4) MLI
	survival	survival	survival	survival
lnnr_f_p_sd	-0.0360** (0.0156)	-0.0290 (0.0252)	-0.0390 (0.0531)	-0.158** (0.0705)
lnnr_f_sp_sd_other	0.0135 (0.0100)	-0.00254 (0.0121)	0.0263 (0.0178)	0.0459 (0.0327)
lnnr_sf_sp_d	0.132*** (0.00875)	0.138*** (0.00902)	0.163*** (0.0318)	0.0988*** (0.0337)
lnnr_sf_p_sd	0.0446*** (0.00614)	0.0179*** (0.00602)	0.0239 (0.0215)	0.0640*** (0.0229)
comp_adv	0.00112 (0.00194)	0.00835*** (0.00239)	0.00339 (0.00235)	0.0119* (0.00696)
Observations	12440	10436	4001	1484

Note: Year, destination and industry (HS-2) fixed effects used. Robust standard errors are clustered on the level of product-destinations.

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Chapter 5

Trade as engine of creative destruction

This part of the dissertation has been written with two co-authors: Leonardo Iacovone from the World Bank Africa Department and L. Alan Winters, Professor at the University of Sussex. I presented it at various conferences in Europe and the United States, as well as to political boards such as USITC (United States International Trade Commission) and the World Bank Research department.

5.1 Abstract

This paper exploits the surge in Chinese exports from 1994 to 2004 as a natural experiment to evaluate the effects of an exogenous shock from competition on Mexican producers. The effect of this competition operates as selection at both firm and product-level as its impact is highly heterogeneous both on the intensive and extensive margins. Sales of smaller plants and more marginal products are compressed and are more likely to exit, while larger plants and products exhibit an opposite effect. Similar results hold both on the domestic market as well as for competition facing Mexican exporters on a third market (i.e. the United States).

5.2 Introduction

Between 1990 and 2007 Chinese exports grew from 62 billions USD to 1.2 trillions USD, at the staggering average rate of about 20 percent per year. According to WTO data China "is set to overtake Germany as the largest goods exporter in 2009".¹ The emergence of China and its impact on producers worldwide has been the focus of the attention of both policy-makers and researchers.

¹Quoted from the Financial Times article "China set to be biggest exporter", published on July 23, 2009 by Frances Williams.

At the same time, policy makers concerned about the adverse consequences of such shock have been voicing their concerns and argued for the importance of protecting their industries.²

The emergence of China has caused angst among policy-makers on all continents and at all levels of development. As argued in Winters and Yusuf (2007), however, in the near term there is probably relatively little to fear for OECD countries because their specialization in sophisticated products and in capital goods insulates their main producers from much of the competition. The pressure on the less sophisticated sectors and firms is in some sense pushing in the direction of improved overall economic performance by speeding up creative destruction. Similarly, policy-makers in low income countries often worry that China will leave no room for them in the markets for labor-intensive manufactures, but in fact as China becomes richer, its comparative advantage is shifting away from the simplest goods towards a middle range. Thus low income countries are also relatively insulated from the force of Chinese competition. Arguably the most direct competition is on middle-income countries whose established positions in manufactured markets have come under threat. This is the focus of this paper.

The main contributions presented are the closure of two gaps in the literature. On the one hand we provide a detailed investigation of the causal impact of competition on the intensive and extensive margin of products in addition to plants. On the other hand we evaluate this same impact on a third country market.³ On both these markets we find strong heterogeneous effects of the competition shock on the extensive (firm exit and survival) and intensive (sales of plants) margin of plants. We also find evidence of product reallocation within plants as competition pressures them to focus on their core competencies (in this context see also Iacovone, Javorcik (2008), Eckel et al. (2009)).

We come to these results by treating the emergence of China on the export markets as a natural experiment of a strong and sudden surge of competition on manufacturing producers of Mexico. As depicted in figure 5.1 the growth rate of Chinese exports to Mexico and the United States increased substantially in value and share during the period considered. This sizeable growth was matched by a moderate increase of trade flows into the other direction; the share of exports from Mexico to China increased from 1.9 to 2.8 percent from 1994 to 2004.⁴ Hence we interpret the situation at hand as a unilateral trade shock and not a mutual trade expansion.

Mexico is one of the countries that is likely to be effected strongly by Chinese competition, given that within NAFTA Mexico has had a comparative advantage for the production of labor intensive goods. Given that the large majority of Mexican exports go to the United States, the choice of country also allows us to go beyond domestic competition and to study the impact of the Chinese export shock

²Some examples from the media to highlight this point: "[We] must not repeat the mistakes of the nineties, when an 'invasion' of Chinese products destroyed entire sectors of our industry [...]" (Medium Enterprises Association of Argentina, April 6, 2004), or: "I made it very clear to Minister Bo Xilai that we will take the legal steps to give Brazilian industry the right to protect itself" (Brazilian minister for Industry, Development and Commerce after meeting with his Chinese counterpart, October 4, 2005.)

³We should underscore that the share of Mexican exports to the US is larger than 85%, in this sense we are analyzing the impact on the near universe of the Mexican exports.

⁴Source: COMTRADE. See also Dussel Peters (2007).

on export markets (ie. the United States), which to our knowledge has not been done before. The objective of this study is to provide an example of how trade can work as a force of creative destruction that leads to competition enhancing readjustments within and across firms. For this reason we focus on both reallocation between firms and within firms, at product level.

There have been several recent studies that investigate the impact of Chinese competition on sectoral level.⁵ These studies have shown where the pressure has arisen and its final effect, but they are not able to address the details of how economies adjust to this pressure. Adjustment is undertaken by firms which find their market positions eroded and it is only by studying firms that we are able to see whether Chinese competition induces an active response in terms of, say, innovation, introducing new products or giving up on old ones, new investment, etc, or a passive one in terms of cuts in investment and employment. And only firm level analysis can see whether competition undermines the heart of an industry or merely speeds up the decline of its periphery. These answers are important missing elements in the discussion of the full impact of China emergence on incomes and growth.

Firm-level studies of Chinese competition are rare. Among the few examples are Bernard, Jensen and Schott (2006) or Fernandes and Paunov (2008). However, none of the existing studies investigates the impact of competition on product level, or analyzes the impact of Chinese competition at firm- or product-level in a third export market.

In addition to these findings our results are also of relevance for firms and policy makers alike. We show how the rise of China affected production patterns in Mexico, and suggest that larger, more productive firms and products are relatively shielded against the adverse effects that this competition poses.

The rest of the article is organized as follows: Section 5.3 discusses some related literature, section 5.4 describes the applied data and strategy. Section 5.5 describes the results of the investigation, and section 5.6 evaluates some additional explanations that might be brought forward. Section 5.7 concludes.

5.3 Related Literature

Our work is related to several areas of research. Most studies analyzing the impact of the emergence of China on the world markets deal with the effect on developed countries, for which the pressure has a possibly constructive intersectoral effect. We ask about a country whose comparative advantage lies firmly in the same sort of sectors and sophistication as China's, as Mexico's comparative advantage within NAFTA lies in labor intensive goods.

First, there exists a large number of studies that rely on sectoral trade flows data to assess the competition threat from Chinese exports to Latin American producers (Freund, Ozden (2006), Hanson,

⁵See for example Freund, Ozden (2006), Hanson, Robertson (2007), Lederman et al. (2008), Soloaga et al. (2007), Devlin et al. (2006), Lall et al. (2005).

Robertson (2007), Lederman et al. (2008), Soloaga et al. (2007), Devlin et al. (2006), Lall et al. (2005)). Other studies have evaluated the impact Chinese exports on wages and employment for various parts of Latin America, see Levinsohn (1999) for Chile, Pavcnik and Goldberg (2005) and Eslava, Haltiwanger, Kugler and Kugler (2009) for Colombia, Blom, Goldberg, Pavcnik and Schady (2004) for Brazil and Pavcnik (2002) for Chile. A sectoral study of the effects that Chinese imports to the US had on Mexican imports to the US finds some evidence for crowding out on this third market (see Iranzo and Ma (2006)). In a broad study Jenkins, Dussel Peters and Mesquite Moreira (2008) suspect that winners as well as losers should be expected in Latin America as a consequence of China's emergence.

Previous firm level studies highlight that trade not only hurts producers but also pushes them to improve their efficiency and organization. Bloom, Draca and Van Reenen (2008) find that imports from China to Europe increase the innovative activity of surviving firms in Europe, while they decrease the chances of survival and employment. Bernard, Jensen and Schott (2004) show that Chinese competition in the US pushes high wage and high skill companies, and causes the decline of low wage and low skill industries. Bernard, Jensen and Schott (2006) investigate how firms react to exposure to international trade and show that plant survival and growth are negatively correlated with competition, but skill intensity, and industry switching positively.⁶

The question of the impact of trade on product level and within-firm reallocations however is with a few exceptions unexplored. Bernard, Redding and Schott (2009a) find that the impact of product switching on US manufacturing growth is as large as that of firm exit and entry to the market, Baldwin and Gu (2005) find evidence that competition reduces diversification of Canadian producers. Eckel, Iacovone, Javorcik and Neary (2009) show that Mexican producers tend react to NAFTA trade liberalization by focusing on their core competencies. Fernandes and Paunov (2008) present evidence of product upgrading in response to competitive pressure among Chilean producers.

Further numerous theoretical articles in the emerging trade models on multi-product firms are closely related to our analysis. Bernard, Redding and Schott (2009b) create a model of multi-product firms that predicts the demise of the less productive firms and products resulting from trade liberalization. The model by Eckel and Neary (2009) suggests that within-firm adjustments, as a consequence of trade reforms might generate substantial gains due to higher efficiency. Related models include Melitz (2003), Melitz and Ottaviano (2009), Aghion et al. (2005).

Mayer, Melitz and Ottaviano (2009) is the model most closely related to our study as it extends Melitz and Ottaviano (2009) by introducing a multi-product dimension and thus give clear predictions on the effects of a unilateral increase of competition. They find that domestically an increase in the competitive pressure leads firms to drop their marginal products (the ones that also have a lower share in production), and reallocate their resources to an increased production of the remaining goods. The inter-firm reallocations generate an additional aggregate productivity increase. For export markets they predict that more competition will lead to a dropping of the less substantial products

⁶In this context see also Arroba et al. (2008), Bernard and Jensen (2007) and Yusuf et al. (2007) and Teshima (2009).

and firms.

5.4 Data and Empirical Strategy

Mexico is one of the countries most intensely affected by the emergence of Chinese exports (see Freund and Ozden (2006), Hanson and Robertson (2007)). Between 1994 and 2004 the value of Chinese imports to Mexico increased exponentially from 0.5 to 14.4 billion USD, which corresponds to an increase of the share of Chinese imports in total imports from 0.6 to 7.3 percent (see graph 5.1, source: COMTRADE). In the same period the imports to the US increased from 41 to 201 billion USD, which corresponds to an increase from 6 to 14 percent of imports and reflects a substantial impact to the US market.

To investigate this relationship further we rely on the Monthly Industrial Survey (EIM) data on Mexican plants provided by the Mexican Institute of Statistics (INEGI) which covers about 85 percent of Mexican industrial output. This unique survey contains detailed information on sales and exports of each of the products manufactured by Mexican plants as well as information on employment broken down by skills.⁷ Further, we use trade data from COMTRADE at HS-1996.⁸

Because the production database relies on the Mexican Industrial Classification CMAP-1994 (Clasificacin Mexicana de Actividades y Productos) at product level (i.e. 8-digit), while the trade data is based on the HS-1996 classification provided by the World Custom Organization at 6-digit level we match the individual product code manually using its description.⁹ In cases when a correspondence was not found we exclude those products from our dataset. Whenever more than one HS code corresponds to one CMAP product we use the average trade value across the different HS codes.

After merging the trade and plant-product level datasets we are left with information on 2744 individual products and a number of plants varying between 6219 and 4439 because of attrition during our sample period (from 1994 to 2004). The main variables of this dataset are described in table 5.2. The specific measure of exposure to foreign competition at individual plant-product-level we apply is the share of Chinese in total imports in the market concerned, while on plant level we compute the weighted average of this measure for the produced products of each plant, and the weights are equal to the sales share of each product.

⁷These datasets have been used and described in previous studies, see for example Iacovone 2008b and Iacovone and Javorcik 2008

⁸For the bilateral trade transaction we rely on the reported imports since it is generally believed that the importer-reported data tend to be more accurate.

⁹We conduct the match of these databases relying on the English and Spanish HS 1996 classification obtained from the Export Helpdesk of the European Union (Export Helpdesk, 2009) and the Spanish language HS classification obtained from the SICA project from the Ecuadorian Ministry of Agriculture and Livestock (SICA, 2009).

Using this dataset we estimate the following equation:

$$y_{it} = \beta_1 Z_{it-1} + \beta_2 Z_{it-1} x_{it-1} + \beta_3 X_{it-1} + \lambda D_t + \mu F_i + \epsilon_{it}, \quad (5.1)$$

where y_{it} is a plant specific outcome variable of interest for plant i at time t , Z_{it} a measure of the Chinese competition shock, X_{it} a set of control variables and $Z_{it}x_{it}$ the interaction of the Chinese competition with x_{it} , a subset of X_{it} . Several other studies have used the import penetration rate from China or broader classes of low-wage countries, for example Broda, Romalis (2009), Bernard, Jensen and Schott (2006) or Bloom, Draca and Van Reenen (2008). λD_t denotes a year fixed effect and μF_i is a plant fixed effect.¹⁰ Our measure of Chinese competition Z_{it-1} is the share of Chinese in total imports to either the US or Mexico. The control variables we use are the value of total imports, the size of plants, a Herfindahl index of product market competition the export share and the ratio of white to blue collar workers (skill share).

We estimate a similar model to investigate the effect on product level. The only difference is that we rewrite the equation in terms of product i , which involves product specific outcomes, control variables on product and plant level, and plant-product specific fixed effects. Generally we cluster standard errors on the level at which we observe the competition from China.¹¹

Aware of the potential endogeneity concerns that could bias our estimates of β_1 and β_2 , our main variable of interests, we rely on instrumental variable estimators to tackle for the possible exogeneity of Z_{it} . As instruments we use Chinese exports to the EU and separately Chinese exports to the world excluding US and the EU. Further we create the interactions of these export numbers with x_{it} which provides us with additional instruments for the regressions that involve interaction terms.

A potential concern about the exogeneity of the instruments is that common trends might affect both Chinese exports and Mexican firms. However, as is widely believed, at the heart of the rise of China lie policies such as the relaxation of prohibitions of economic activities which encouraged activity, stronger property rights and improvements of governance (see Keefer (2007) or Huang (2003)).

Another concern is that plants and products affected by competition from China might differ initially from those that are not. As depicted in figure 5.1, Chinese trade to Mexico increased considerably after 1998, the Chinese shock could be dated for the period after. We create an indicator of firms that were affected by Chinese competition during the years 1998-2004, and regress log sales on firm level for the years 1994-1998 on that variable. In this sample of over 26.000 observations we do not find initial sales differences between firms facing later competition and firms that do not (with a p-value of 0.912).¹²

¹⁰ D_t is a variable equal to zero in all years except t , and one in t , F_i is equal to zero for all plants except for plant i .

¹¹At the product level the competition varies at 8 digit CMAP codes, which is the cluster we apply. At the plant level competition varies at plant level only, since competition for each plant is a weighted mean of its products and thus plant specific. Given that we apply plant fixed effects, we do not apply clusters in the plant regressions. Such clustering treatment is consistent with Moulton (1990).

¹²A similar exercise for exit can't be undertaken in the same way, given that competition is plant-year specific,

A final concern is that when we estimate the equation with sales as outcome, we use a lag-dependent variable and an interacted lag-dependent variable in panel data with fixed effects. As shown by Nickell (1981), the coefficient on the lagged variable is likely downward biased. The size of the bias, and in particular the bias for the interacted variable is unknown. In Appendix 1 we run a simulation to show that the lag-dependent variable, its interaction and the exogenous variable used in the interaction are all three biased towards zero, hence our results are likely to underestimate the true size and significance of the impact in these regressions.

5.5 Results

Sectoral level

First we investigate the relationship of Mexican competition and sales at sectoral level, for which we aggregate the data to six digit CMAP level (table 5.3). In the OLS regressions we find no significant effect of the Chinese import share on sales in Mexico on sectoral level. This is in line with the results of other studies involving aggregate data, which also find a small or insignificant impact (for example Wood and Mayer (2009)).

However, there is a positive effect of the Chinese import share to the US on exports of Mexican plants to the US. The instrumental variable estimates are negative and significant at 1 percent level for both the export and the domestic market. The first stage of the IV estimates shows a strong correlation with the instruments, and a Sargan test of exogeneity of the instruments and a test of underidentification do not indicate invalidation of either. Thus we find evidence of competitive pressure of Mexican manufactures due to Chinese competition both domestically and in the third market. The difference between the OLS and the IV regressions highlights the need to take into account endogeneity problems.

Our argument is, however, that these results at sectoral level hide an important amount of heterogeneity at firm and product level. With this objective in mind we move to a finer degree of disaggregation and investigate the impact of Chinese competition on both the extensive and intensive margin, and on plant and product level.

Plant level regressions

In all the following regressions we exclude some data outliers such as plants reporting to export more than they what sell overall and plants characterized by extreme values in the rates of Chinese imports growth.¹³

and we do not observe future competition for plants that exit. With log export sales the corresponding p-value is 0.07, hence it is also not significantly different at five percent level of significance. The lower p-value in the export market might reflect the fact that Chinese imports to the US were already observed in the years 1994-1998.

¹³We exclude those instances when Chinese imports increase by more than 300 percent or decrease by more than 90 percent within a year, since given that the trade values are weighted means of product competition such huge changes are more likely to reflect changes in the product mix than in actual competition. In total these outliers amount to about 10 percent of the data. Our results are robust to the inclusion of outliers, however.

At plant level we first investigate the relationship between the Chinese competition and plant exit from the market (see table 5.4) for the OLS and table 5.5 for the IV results and the first stages. The plant exit variable used as an outcome in table 5.4 is a dummy variable that is equal to one if a plant has positive sales at times $t - 1$ and t , and no sales at time $t + 1$, and zero otherwise. Hence this variable indicates the year during which a plant leaves the market. We control for the following lagged variables on plant level: the log total imports to Mexico, log total sales of the plant, the Herfindahl index as a proxy for sectoral competition (a measure which is also a weighted mean of the competition for each of the product manufactured by the plants), the plant's export share and the ratio of white to blue collar workers. Additionally we include plant and year fixed effects. This rich set of control variables allows us to condition the results on numerous sources of differences of the Mexican firms and thus to eliminate noise.

In the first column we find that when excluding the main interaction term between size and Chinese competition, in this specification Chinese domestic competition in $(t - 1)$ has no significant conditional mean effect on plant exit in the OLS regressions, a result which is confirmed in the IV regression. The second column presents the results with an interaction of Chinese competition with the Herfindahl index of product competition, which is in OLS insignificant. In the third column we find that more export oriented plants are less likely to exit as a result of competition, but this result is not significant in IV estimation.

Finally we include an interaction between plant sales and Chinese competition (forth column). As suggested by the literature (see for example Mayer et al. (2009), Melitz (2003), Melitz et al. (2009)) we think of plant size being correlated with productivity and/or managerial ability. In this last specification we uncover a significant asymmetric effect: plants with smaller overall sales are more affected by Chinese competition than larger plants. The marginal effect of competition on the probability of exit is estimated to be $0.77 - 0.07\ln(\text{sales})$ in OLS. The mean and median log plant size are around a value of eleven, the percentile at which the mean estimated effect is zero is around 70. This significant result for the extensive margin also holds qualitatively in the IV regression.¹⁴

In the first stage equations, shown in table 5.5, "China comp. -EU -US" shows the export share of China to the world with the exception of the EU and the US, and "China exp EU" shows the export value of China to the EU. The terms "interaction instrument 1" and "interaction instrument 2" are the interactions of these instruments with the variables interacted in the IV regressions.¹⁵ The p-value of the Sargan test of exogeneity of instruments, the p-value of a test of underidentification and the F-value of the first stage are also displayed. The F-statistic suggests a strong explanatory power of the first stage, with strong positive correlation of exports to the EU and to the rest of the world with Chinese exports to Mexico. The Sargan test of exogeneity does not suggest a problem of endogeneity.

¹⁴If the IV coefficients are larger than OLS this is usually interpreted as unobserved response heterogeneity, which is commonly observed in similar contexts. See for example Lileeva and Treffer (2009) or Card (2001).

¹⁵For example: "interaction instrument 1" in the regression with the export share interaction is equal to the first instrument ("China exp world-EU-US (t-1)") times the lagged export share.

We repeat a similar estimation with outcome variable plant exit from export market in tables 5.6 (OLS) and 5.7 (IV and first stage). In these regressions we focus on the subset of firms that have a positive export share only, and analyze how the shock of Chinese exports to the US affected their likelihood of exiting from export markets. As before we control for log imports to the US, competition, firm size, the skill share and the export share of firms. A similar pattern emerges: An increase of Chinese competitive pressures in the export market does not increase the probability of Mexican plants withdrawing from exports in the first column. This mean effect is also not significant in the IV regression.

OLS further suggests that firms with a larger export share (which might be thought of as more productive firms) have a lower probability of exit. This effect disappears in IV. What is significant in both the OLS and IV estimation is the evidence on the asymmetric size effect of competition. In fact, the interaction between plant sales and Chinese competition abroad is negative and significant while the coefficient on the competition alone is positive and significant. An increase in competitive pressures on the export market makes Mexican exporters more likely to stop serving it, but this average effect is weaker for larger and more productive plants. Again in the first stage, the Sargan test does not suggest a problem of endogeneity, and the F-values are large.

Next we turn to investigate plant's responses on the intensive margin, ie. firm sales. Table 5.8 shows the OLS results where log domestic sales on plant level are the explained variables. First of all, we show in the first column that we do not find any average affect due to increased Chinese competition. However, when we include an interaction term between the degree of Chinese competition and plant size we find that while on average an increase in competition reduces plant-level sales, this effect is highly asymmetric, as the larger a plant is (in the regression measured by export sales) the less it responds by reducing its sales. In other words, Chinese competition pushes smaller and less productive plants to become even smaller while larger and more productive ones are less or not affected (column 4).

This result also holds qualitatively in the IV regressions (table 5.9), while here two more interactions give significant results: Everything equal, plants that export more are less likely to exit from the market. We think of these plants as the more productive ones. The significant Herfindahl interaction suggests that markets with low level of competition are forced to reduce their sales more than plants in markets where they already operate under more competitive circumstances.

In the corresponding export market regressions for exporting plants (see table 5.10 for OLS and table 5.11 for IV) the same pattern emerges. We do not find an average effect of competition from China on the export markets in IV, but again we find in both OLS and IV that the impact of competition is asymmetric forcing smaller plants to reduce their exports sales while the larger ones' response is the opposite, as shown by the coefficient on the interaction term between Chinese competition on the export market and plant's sales (column 4 in both tables 5.10 and 5.11). The export share and Herfindahl interactions behave similarly to their domestic counterparts.

Quantile regressions

In the previous section we highlight an important asymmetric effect of size on exit and sales; namely that larger plants appear less effected by the adverse effects of the Chinese competition shock. However, in the previous model we impose a linear restriction on the heterogeneous effect to size. With these specifications we impose a linear relationship to size. To explore the nature of this asymmetric effect further, and also to allow for different effects at different levels, we perform quantile regressions and quantile IV regressions of the domestic size regression (see table 5.12 and table 5.13).¹⁶ The results reveal a similar relationship with a negative distributional effect below the median and a positive effect above in OLS and IV. The relationship suggested by the quantile and quantile IV regression is increasing and concave, with strong differential changes at the lower end of the distribution.

In table 5.14 we use the ratio of white to blue collar workers as a measure of skill intensity of plants, and interact this measure with the log value of Chinese imports to Mexico. The coefficients on Chinese competition show again the tendency to disappear with size. We use the estimates of this table to draw the marginal effect of competition on a size-sales surface. This allows also to show that the impact of competition for firms with the same size but different skill shares, as well as the impact of holding the skill share constant and varying size. Figure 5.2 displays a size - skill surface. The figure suggests the effect of competition is most hurtful for the smallest and least skill intensive plants, and it increases when moving along either the size or the skill axis.

Intermediate inputs

So far we have not considered the effect of Chinese exports on inputs into Mexican manufacturing. This is another important test, since Mexican production might be influenced greatly due to changing prices of available inputs. This might be an additional influence driving plant exit and sales, and omitting it could cause the results presented to this point to be biased.

To account for this concern we generate a measure for the Chinese shares in inputs using the input-output tables for 2003 provided by INEGI and the Chinese trade values from COMTRADE.¹⁷ For the computation we weight each sector listed as input by its imports share, and the import share by the Chinese share in inputs for that sector. This is equal to the weighted sum of inputs imported from China at sectoral level where the weights are given by the coefficient of the input-output table. Total imports from China for a sector are positively correlated with Chinese imports for inputs to that sector as apparent from figure 5.5.

Table 5.19 provides the main regressions for plant exit and sales on the domestic and export market with plant size interactions with the addition of the measure for the Chinese importance in inputs and the interaction of this variable with plant size. Absent the addition of these two variables, the regressions provided in this table are identical to column 4 in tables 5.4, 5.6, 5.8 and 5.10, although we only provide the main variables of interest. While for some of the previously used coefficients the significance is reduced, qualitatively the results remain the same. The inputs variable mimics

¹⁶For the implementation of the quantile IV regressions we use the strategy and codes developed by Chernozhukov and Hansen (2006).

¹⁷Given the size of the available input-output table this variable is computed at sectoral level (with 32 sectors) only.

the results of Chinese imports; for small firms it increases the probability of exit and reduces sales, while the contrary holds for larger firms. This provides evidence that the larger plants are able to capture potential benefits of Chinese competition on the input markets better than their smaller competitors. This might be an important channel of why plants of different size are differently effected by competition, but other asymmetric elements remain present.

Product level

Next we investigate the extensive margin responses at product-level. Similar to the definition of plant exit, product drop at time t is equal to one if a product is manufactured at time $t - 1$ and t , but not at $t + 1$ and $t + 2$.¹⁸ In these regressions we control again for log total imports, for the skill share, product market competition, the number of products of a firm, the export share of that product, and the share that the product has within the firm.

Table 5.15 shows the overall drop of products as a consequence of Chinese competition. In this exercise we restrict the sample to those plants that produce more than one product only. In all product regressions we use plant-product fixed effects (such that product i produced in plant j differs from product i produced in plant k , and also from product l produced in plant j) and cluster robust standard errors by product categories (CMAP 8-digit). On average, we find a positive and significant effect of Chinese competition on the probability of exit in the OLS and the IV regressions. The second and forth column introduce an interaction with the share of products within plants. We think of a product with a larger share as a more profitable product (Mayer et al. 2009) or “core products” (Eckel and Neary 2008, Eckel et al 2009). Also at product level we find evidence of selection effects as the impact of Chinese competition is asymmetric across products. Core products, or the ones that represent a larger a larger share of plant’s sales, are less likely to be dropped. This heterogeneous responses at product level are confirmed in our IV regressions as shown in the fourth column of Table 5.15.

We repeat the exercise for products in the export market, restricting the sample to exporting plants. The only change of structure is, that in these regressions we control additionally for the exit of plants from export. Product drop from export at time t is defined, as before, equal to one when a product is exported at time $t - 1$, in t , but not $t + 1$ and $t + 2$. In these regressions we control additionally for the exit of plants from all markets, and from export markets. The coefficients on the variable measuring the degree of Chinese competition in the US market are not significant when this variable is not interacted with the share of product on total plant sales. However, once more we find, both in OLS and IV regressions, evidence of reallocation and heterogeneous responses as the interaction between the degree of Chinese competition and the share of products sales is negative and significant. This indicates that core products are less likely to exit export market in the face of Chinese competition.

Next we investigate the responses along the intensive margin at product level. Table 5.17 confirms once more the “creative destruction” effect of competition and its reallocative consequences with less important products being forced to contract while “core” products expand. In column 1 of Table 5.17

¹⁸Alternatively we have tested the robustness of our results by defining product drop at time t equal to one if a product is manufactured at time $t - 1$ and t , but not at $t + 1$ and our results are substantially unchanged.

we show there is actually no mean effect of competition, however when we introduce an interaction term between competition and product's share in column 2 we find that there is a significant asymmetric effect as while the coefficient on the variable capturing competition alone is negative and significant, this is counterbalanced by the interaction term pointing toward the fact that while competition forces a contraction along the intensive margin on average this effect is attenuated, and eventually reverted, for the "core products". This results are consistent across OLS and IV estimation (column 2 and 4 in Table 5.17). The only case when this "asymmetric" effect of competition does not emerge is Table 5.18 where we present the product-level response to the Chinese competition on the export market. In this case, both in the OLS and IV estimation, we find a significant and negative effect of Chinese competition on product-level sales.

The product regressions all include firm-product fixed effects and thus provide within plant-product effects. A less strict setting is provided in the appendix, where we replace the plant-product controls by industry control variables on CMAP-8 level. The results remain similar in sign but change in magnitude and level of significance.

Quantile regressions at product level can not be applied as a direct extension of the interacted column, since in the product regressions on sales the interactions are size shares and the outcomes size. When we perform a quantile regression of the interaction equation in table 5.17 (first column) this can thus not be directly compared to the second column, since the quantiles represent sales and not sales shares. In the appendix we provide these quantile results, which show that the effect of competition is significantly negative for small products, and positive for large products and not significantly different from zero for the medium ones.

Graphical representation

To summarize, we found strong impact of Chinese competition on exit and sales on plant and product level: Smaller plants and products are more likely to exit, and larger plants and "core products" are shielded more to the increasing competition. Further we present evidence that the competition induces firms to focus on their core products.

These relationships are summarized graphically in figures 5.3 and 5.4, where the x-axis shows sales centiles and the y-axis the marginal effect of competition for firms of that size, which is derived from the corresponding IV regressions using the coefficient on Chinese competition and on the interaction term multiplied by the corresponding size. The shapes and significance of these curves reflect the results previously described: larger plants and products are less effected by Chinese competition in terms of sales and exit probability. Magnitudes can be readily obtained from these graphs; for example the exit graph in figure 5.4 suggests that an increase of one percent of total imports of Chinese imports for a certain good translates into an increased exit probability of 0.5 for these products on the domestic market if they occupy 10 percent of plant sales, and it does not increase the exit probability for goods that occupy 90 percent of sales of a plant.

These graphs highlight the asymmetry of the impact. Note that for the computation of these graphs we use only the two coefficients that include our measure of the competition from China, which represents

the estimated marginal effect. If however the partial derivative of any other coefficient with respect to competition is non-zero, the intercept of the graphs would be shifted.

5.6 Robustness

To account for robustness of our results we perform various robustness tests. First, in table 5.20 we rerun the results on plant level separately for the 20 percent of plants most affected by competition and the 20 percent least affected, measured by mean competition. This is a check of the plausibility of the estimation setup; we expect to find no effect in those plants in which Chinese imports are a small fraction of all competition, and a strong effect in the sample of plants that are strongly effected by Chinese competition. The tables shown are identical to the fourth column of tables 5.4, 5.6, 5.8 and 5.10 and these regressions are identical, but we only provide the main coefficients of interest. Most of the coefficients move away from zero in the subsample of the top 20 percent, while the effects are fully gone in the sample of bottom competition.

A second robustness check is provided in table 4.13, in the panel labeled “placebo”. In this table we compare sales in the period of 1994 to 1998 to the future competition of plants, that is the competition that they would experience four years later. We believe that this future competition is unknown to plants and therefor meaningless to current behavior. The coefficients are all insignificant, which is another robustness check for the data. Similar tables for exit could not be computed, since we do not observe the plant-year specific competition of plants for plants that exit the sample.

It seems that Mexican policy makers were aware of the impact of Chinese competition, since they filed a large number of anti-dumping cases against China (the anti-dumping data was taken from Bown (2009)). A sixth of the products in our sample was subject to a successful Mexican anti-dumping complaint, which presents room for alternative interpretations for the findings. In particular, we face the problem that the endogeneity of the anti-dumping cases leads to a reverse causality of Mexican plant behavior on Chinese imports. To address these issues we repeat the plant level analysis only for those products with no anti-dumping case. These results are shown in the right panel in table 5.21. Our results remain similar in terms of size and significance.

Another concern is that specific developments in the technology of certain goods might influence the results, if they affect Chinese exports and Mexican firm behavior adversely. To confront this concern we include industry-year fixed effects into the main specifications.¹⁹ The main results remain the same in size and significance, and are not significantly different in terms of magnitudes (see table 5.22).

¹⁹These are based on HS-2 digit industry measures. A more disaggregated level such as HS-6 would be perfectly correlated with Chinese competition, and thus take out the variation of our right hand side variable of interest.

5.7 Conclusions

The surge of Chinese exports provided us with a quasi-natural experiment to evaluate the impact of a surge in competition on the extensive and intensive margin both at plant and product-level. In this study, for the first time to our knowledge, we analyze the impact of such competitive pressures both on the domestic market as well as on the export market on sectoral, plant and product level.

We find that the surge of China challenges Mexican firms, and leads to plant exit, the loss of products and contraction. These effects are asymmetric along many dimensions: First, and most crucially, we show that indeed the effect of competition is highly asymmetric because while smaller and less productive plants are forced to shrink and exit from the market, this effect is attenuated and eventually reversed for larger and more productive plants. Second, we show that this process of “creative destruction” and market selection does not operate only at firm- but also at product-level. Third, such heterogeneous micro-level results are hidden by average effects at sectoral level pointing towards the need to use firm- and product level data and allow for heterogeneous effect through interaction terms.

These results highlight that the rise of Chinese exports influences existing production patterns, a question of great relevance to policy makers and firms worldwide. We show that while a crowding out effect is observed for less productive plants, the more productive larger plants can cope with this competition. These results, of course, do not tell us how the advent of China as a world trading power has affected Mexican welfare. They pay no regard to consumption benefits, nor to the extent to which competition in manufacturing has led to growth in other sectors. Even within manufacturing the extent of the aggregate shock is not always clear. What the results do show, however, is that resistance to Chinese competition is possible and that it entails ‘moving up market’. The future of Mexican manufacturing appears to lie in greater efficiency and sophistication and that policy responses to Chinese competition should be in this direction rather than defensive. Thus, for example, policy should permit and facilitate change, rather than frustrate it by supporting failing firms. It should recognize the centrality of large and efficient firms to the response, than focusing on small and medium enterprises, it should promote skills and innovation by permitting them to earn high rewards when they succeed. These are not new messages - many policy-makers have advocated this at a firm or a sectoral, or even an economy-wide level - but this paper is the first to have produced proof for that proposition.

These results reinforce the messages emerging from the recent theoretical literature on heterogeneous firms spurred by the seminar paper of Melitz (2003) and recently expanded towards the introduction of a further layer of heterogeneity at product-level (Eckel and Neary 2008, Bernard et al 2008, Mayer et al 2009).

Still pending for future research agenda is to understand more in detail the mechanisms through which this “heterogeneous” responses operates at firm- and product-level, such as the role of innovation, firm organizational practices, skills and workers’ training.

5.8 Appendix 1: Bias

As is often highlighted in the econometric literature, a fixed effects model with lagged dependent variables is likely biased. While the size of that bias for a model with a lagged dependent variable has been described (Nickell (1982)), we are not aware of a formulation of the bias of an interacted lag dependent variable. To investigate this bias we undertake a simple simulation exercise.

We generate a panel data of 1000 firms over a time period of 10 years. We generate a simulated competition variable, which is distributed iid. uniformly between 0 and 1 (just as the Chinese imports share in the previous analysis is bounded by 0 and 1). In the first period sales are exogenously given and distributed iid. standard normally. In each further period we generate sales for firm i in period t as:

$$Sales_{it} = Competition_{it-1}\beta_1 + Sales_{it-1}\beta_2 + Sales_{it-1}Competition_{it-1}\beta_3 + \epsilon_{it}$$

The error terms ϵ_{it} are iid. standard normally distributed. We assume the parameters: $\beta_1 = -0.5$, $\beta_2 = 0.5$, $\beta_3 = 0.5$. After computing the data we estimate above model with the inclusion of firm fixed effects. To see the direction and size of the biases of the coefficients, we repeat described data generation and estimation 1000 times. Table 5.1 reports how often the estimated coefficient was significantly (at five percent level) below or above its true value, and how often we could not reject that it is equal to zero. This count reads as follows:

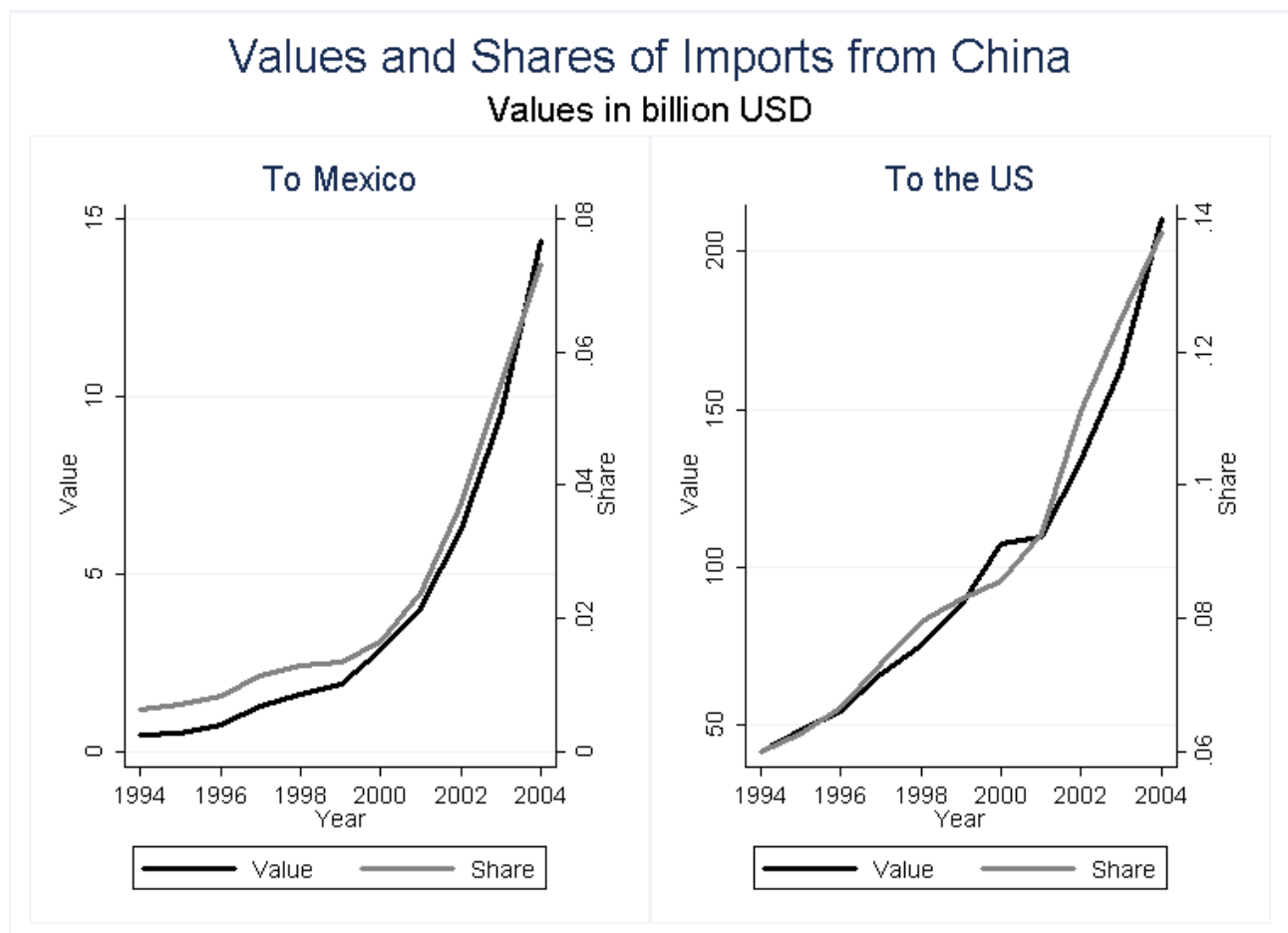
Table 5.1: Simulation results

Coefficient	Below	Above	Zero
Sales	1000	0	0
Competition	3	118	0
Interaction	182	2	0

The coefficient on the lagged sales is always below its true value of 0.5 (at five percent level of significance), and always above zero. The coefficient on lagged competition is 118 times above its true value of -0.5, three times below it and never zero. This suggests a modest attenuation bias. The interaction is over 180 times below its true value of 0.5, and two times above it. Hence we find evidence for an attenuation bias for all three coefficients that is most pronounced for lagged sales. The OLS sales regressions are thus potentially biased in a way that would lead us to underestimate the true size of the effects, and lower the significance of our estimates.

5.9 Appendix 2: Tables and graphs

Figure 5.1: Imports value and share



The left scales of both graphs denotes import values in billion US dollars, while the right scales show the share of Chinese in total imports. Source: COMTRADE.

Table 5.2: Descriptive statistics

Firm data variables				
	Mean	S. D.	Min.	Max.
China comp. Mex	0.02	0.06	0.00	0.86
China comp. US	0.02	0.09	0.00	0.95
Export share	0.10	0.22	0.00	1.00
ln(Sales)	10.54	1.91	0.00	18.01
ln(Export Sales)	9.21	2.45	0.00	17.84
Skill share	0.31	0.20	0.00	1.00
Nr. of products	3.18	2.93	1.00	33.00
Herfindahl	0.08	0.09	0.01	1.00
Product data variables				
China comp. Mex	0.02	0.06	0.00	0.96
China comp. US	0.08	0.15	0.00	1.00
Share	0.32	0.36	0.00	1.00
ln(Sales)	8.49	2.63	0.00	18.00
ln(Export Sales)	8.14	2.63	0.00	17.84

Note: This table presents main variables used in the regressions. *China comp. Mex* and *China comp. US* denote the shares of Chinese in total imports, *Skill share* the ratio of white to blue collar workers, and *Share* the share of sales of a given product within its firm.

Table 5.3: Sectoral regressions

	OLS		IV	
	Log domestic sales	Log export sales	Log domestic sales	Log export sales
China comp. Mex (t-1)	-0.735 (0.628)		-4.71*** (0.74)	
China comp. US (t-1)		4.049** (2.19)		-11.54*** (3.44)
Year fe.	Yes	Yes	Yes	Yes
Sector fe.	Yes	Yes	Yes	Yes
N	2050	2050	2050	2050
First stage				
China comp.-EU-US (t-1)			0.1165*** (0.0261)	0.1783*** (0.0221)
China comp. EU (t-1)			0.4224*** (0.0376)	0.1982*** (0.3184)
Sargan p-value			0.21	0.13
First stage F-value			41.91	34.95

Note: The *China comp.* variables indicate the lagged share of Chinese imports in total imports to Mexico, to the US, to the world with the exceptions EU and US and to the EU. The underlying data is aggregated to CMAP-6 sectoral level. Stars denote significance at one (***), five (**) and ten (*) percent level of significance.

Table 5.4: Domestic plant exit, OLS

	Domestic exit - OLS			
Chn. comp. Mex (t-1)	0.0266 (0.0463)	-0.0534 (0.0658)	0.0703 (0.0568)	0.770** (0.319)
log tot. imports (t-1)	-0.00157 (0.00141)	-0.00159 (0.00141)	-0.00155 (0.00141)	-0.00150 (0.00141)
log tot. sales (t-1)	-0.0576*** (0.00357)	-0.0576*** (0.00357)	-0.0575*** (0.00357)	-0.0563*** (0.00357)
Herf. (t-1)	0.0891* (0.0459)	0.0730 (0.0463)	0.0909** (0.0459)	0.0924** (0.0460)
log exp. share (t-1)	-0.0139 (0.0133)	-0.0139 (0.0133)	-0.00945 (0.0134)	-0.0137 (0.0133)
skill share (t-1)	-0.00553 (0.0176)	-0.00589 (0.0175)	-0.00588 (0.0176)	-0.00733 (0.0175)
Chn. Herf int. (t-1)		0.510 (0.326)		
Chn. exp share int. (t-1)			-0.297*** (0.104)	
Chn. sales int. (t-1)				-0.0696** (0.0272)
Plant f.e.	Yes	Yes	Yes	Yes
Year f.e.	Yes	Yes	Yes	Yes
Observations	35828	35828	35828	35828

Note: Domestic exit indicates the plants that leave the sample in the consequent period. Robust standard errors used, stars denote significance at one (***) , five (**) and ten (*) percent level of significance. *Chn. comp. Mex* indicates the share of Chinese in total imports.

Table 5.5: Domestic plant exit (IV)

	Exit	Exit	Exit	Exit	FS ChnMex	FS ChnMex	FS ChnMex	FS ChnMex
Chn. comp. Mex (t-1)	-0.0446 (0.110)	-0.262* (0.134)	-0.0630 (0.116)	1.258** (0.514)				
log imports (t-1)	-0.00155 (0.00144)	-0.00161 (0.00144)	-0.00156 (0.00144)	-0.00142 (0.00144)	0.0003 (0.0002)	0.0002 (0.0002)	0.0002 (0.0002)	0.0002 (0.0002)
log tot. sales (t-1)	-0.0575*** (0.00225)	-0.0576*** (0.00225)	-0.0576*** (0.00225)	-0.0553*** (0.00238)	0.0006** (0.0003)	0.0007** (0.0003)	0.0006* (0.0003)	-0.001*** (0.0003)
Herf. (t-1)	0.0904** (0.0367)	0.0372 (0.0391)	0.0891** (0.0367)	0.0969*** (0.0367)	0.0126** (0.005)	-0.0185*** (0.0055)	0.0121** (0.0050)	0.0115** (0.005)
log exp. share (t-1)	-0.0139 (0.0119)	-0.0140 (0.0120)	-0.0166 (0.0127)	-0.0135 (0.0119)	0.0002 (0.00164)	0.0006 (0.0016)	-0.0071*** (0.0019)	-0.0003 (0.0016)
skill share (t-1)	-0.00561 (0.0147)	-0.00673 (0.0147)	-0.00538 (0.0147)	-0.00889 (0.0148)	-0.0029 (0.00202)	-0.0028 (0.002)	-0.0026 (0.002)	-0.0018 (0.002)
Chn. Herf int. (t-1)		1.658*** (0.435)						
Chn. exp share int. (t-1)			0.185 (0.296)					
Chn. sales int. (t-1)				-0.125*** (0.0454)				
Chn. comp. -US -EU (t-1)					0.0161*** (0.00141)	0.0111*** (0.00177)	0.0167*** (0.00142)	-0.00129 (0.00781)
Chn. comp. EU (t-1)					0.428*** (0.00701)	0.387*** (0.00855)	0.412*** (0.00742)	-0.0792** (0.0349)
interaction instrument 1						0.107*** (0.0190)	0.0309*** (0.0114)	0.0019** (0.0008)
interaction instrument 2						0.273*** (0.0491)	0.150*** (0.0283)	0.0488*** (0.0034)
Observations	35376	35376	35376	35376	35376	35376	35376	35376
Sargan p - value	0.706	0.796	0.733	0.239				
F-Statistic					448.4	409.1	402.1	418.3

Note: The first four columns give the results from an IV regression, while the other four columns report the corresponding first stages. Robust standard errors, year and plant fixed effects used throughout, stars denote significance at one (***), five (**) and ten (*) percent level of significance.

Table 5.6: Exit from export, plant, OLS

	Exit from export			
Chn. comp. US (t-1)	0.0321 (0.0608)	-0.0128 (0.0763)	0.233*** (0.0790)	0.798*** (0.221)
log US imports (t-1)	-0.00390 (0.00410)	-0.00390 (0.00410)	-0.00348 (0.00411)	-0.00393 (0.00411)
log exp. sales (t-1)	-0.0369*** (0.00466)	-0.0368*** (0.00466)	-0.0368*** (0.00466)	-0.0319*** (0.00471)
Herf. (t-1)	0.0596 (0.0908)	0.0193 (0.0931)	0.0552 (0.0904)	0.0586 (0.0912)
log exp. share (t-1)	0.0804*** (0.0304)	0.0809*** (0.0304)	0.106*** (0.0308)	0.0827*** (0.0303)
skill share (t-1)	-0.000652 (0.0475)	-0.00127 (0.0475)	-0.00363 (0.0474)	-0.00819 (0.0476)
Chn. Herf int. (t-1)		0.479 (0.468)		
Chn. exp share int. (t-1)			-0.655*** (0.134)	
Chn. exp. sales int. (t-1)				-0.0777*** (0.0202)
Year f.e.	Yes	Yes	Yes	Yes
Plant f.e.	Yes	Yes	Yes	Yes
Observations	11414	11414	11414	11414

Note: In the underlying data only exporting firms are considered. Robust standard errors applied, stars denote significance at one (***), five (**) and ten (*) percent level of significance. *Chn. comp. US* indicates the share of Chinese in total imports.

Table 5.7: Exit from export, plant, IV

	Exit exp.	Exit exp.	Exit exp.	Exit exp.	FS ChnUS	FS ChnUS	FS ChnUS	FS ChnUS
Chn. comp. US (t-1)	0.162 (0.212)	0.0771 (0.210)	0.206 (0.231)	1.577*** (0.579)				
log US imports (t-1)	0.000344 (0.00436)	0.000518 (0.00435)	0.000593 (0.00436)		0.00545*** (0.000650)	0.00525*** (0.000649)	0.00544*** (0.000650)	0.00545*** (0.000650)
log exp. sales (t-1)	-0.00996*** (0.00344)	-0.00990*** (0.00344)	-0.00981*** (0.00345)	-0.000222 (0.00438)	-0.000343 (0.000533)	-0.000361 (0.000531)	-0.000338 (0.000533)	-0.000395 (0.000540)
Herf. (t-1)	0.0467 (0.0922)	-0.00333 (0.109)	0.0451 (0.0922)	8.96e-05 (0.00510)	-0.0293** (0.0143)	0.0199 (0.0159)	-0.0296** (0.0143)	-0.0295** (0.0143)
log exp. share (t-1)	0.0311 (0.0275)	0.0321 (0.0275)	0.0389 (0.0296)	0.0498 (0.0925)	0.00872** (0.00424)	0.00777* (0.00423)	0.00269 (0.00466)	0.00883** (0.00425)
skill share (t-1)	-0.00963 (0.0456)	-0.0102 (0.0456)	-0.0111 (0.0456)	0.0279 (0.0276)	0.00812 (0.00706)	0.00732 (0.00704)	0.00825 (0.00706)	0.00849 (0.00709)
Chn. Herf int. (t-1)		0.602 (0.707)		-0.0260 (0.0462)				
Chn. exp share int. (t-1)			-0.215 (0.311)					
Chn. exp. sales int. (t-1)				-0.136*** (0.0508)				
Chn. comp. -US -EU (t-1)					-0.0264*** (0.00741)	-0.0189* (0.0107)	-0.0323*** (0.00823)	-0.00610 (0.0503)
Chn. comp. EU (t-1)					0.621*** (0.0204)	0.722*** (0.0261)	0.587*** (0.0246)	0.451*** (0.136)
interaction instrument 1						-0.131 (0.0892)	0.0265 (0.0233)	-0.00189 (0.00455)
interaction instrument 2						-0.659*** (0.130)	0.124** (0.0555)	0.0152 (0.0121)
Observations	12089	12089	12089	12089	12089	12089	12089	12089
Sargan p-value	0.317	0.494	0.523	0.279				
F-Statistic					143.1	131.2	127.3	126.4

Note: The first four columns report the results from an IV regression, the last four columns show the corresponding first stages. Only exporting firms are considered. Robust standard errors, year and plant fixed effects applied throughout, stars denote significance at one (***), five (**) and ten (*) percent level of significance.

Table 5.8: Ln Domestic Sales - OLS

	Log Plant sales			
Chn. comp. Mex (t-1)	0.0177 (0.117)	0.0925 (0.134)	-0.0288 (0.120)	-1.200* (0.689)
log imports (t-1)	-0.000420 (0.00497)	-0.000415 (0.00497)	-0.000434 (0.00497)	-0.000497 (0.00497)
log tot. sales (t-1)	0.658*** (0.0136)	0.658*** (0.0136)	0.658*** (0.0136)	0.656*** (0.0137)
Herf. (t-1)	-0.527*** (0.129)	-0.510*** (0.133)	-0.529*** (0.130)	-0.533*** (0.130)
log exp. share (t-1)	-0.956*** (0.0645)	-0.956*** (0.0645)	-0.962*** (0.0654)	-0.957*** (0.0644)
skill share (t-1)	-0.0554 (0.0488)	-0.0551 (0.0488)	-0.0551 (0.0488)	-0.0520 (0.0489)
Chn. Herf int. (t-1)		-0.507 (0.505)		
Chn. exp share int. (t-1)			0.300 (0.550)	
Chn. sales int. (t-1)				0.113* (0.0601)
Year f.e.	Yes	Yes	Yes	Yes
Plant f.e.	Yes	Yes	Yes	Yes
Observations	39254	39254	39254	39254

Note: Robust standard errors used, stars denote significance at one (***), five (**) and ten (*) percent level of significance.

Table 5.9: Domestic Sales - IV

	Dom. sales	Dom. sales	Dom. sales	Dom. sales	FS ChnMex	FS ChnMex	FS ChnMex	FS ChnMex
Chn. comp. Mex (t-1)	-0.485*	-0.0337	-0.237	-6.743***				
	(0.259)	(0.339)	(0.271)	(1.401)				
log imports (t-1)	>-0.001	>-0.001	>-0.001	>-0.001	-0.0003	-0.0003	-0.0003	-0.0003
	(0.004)	(0.004)	(0.004)	(0.004)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
log tot. sales (t-1)	0.658***	0.659***	0.658***	0.645***	-0.0002	-0.0002	-0.0002	-0.0002
	(0.00597)	(0.00598)	(0.00598)	(0.00661)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Herf. (t-1)	-0.518***	-0.392***	-0.498***	-0.550***	0.0100**	0.0004	0.00997*	0.0101*
	(0.0940)	(0.109)	(0.0944)	(0.0944)	(0.00510)	(0.00545)	(0.00510)	(0.00510)
log exp. share (t-1)	-0.955***	-0.954***	-0.906***	-0.960***	0.00111	0.00122	0.0007	0.001
	(0.0322)	(0.0322)	(0.0354)	(0.0323)	(0.00175)	(0.00175)	(0.00183)	(0.00175)
skill share (t-1)	-0.0564	-0.0541	-0.0601	-0.0384	-0.002	-0.002	-0.002	-0.002
	(0.0391)	(0.0391)	(0.0391)	(0.0393)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Chn. Herf int. (t-1)		-3.723**						
		(1.625)						
Chn. exp share int. (t-1)			-2.630***					
			(0.781)					
Chn. sales int. (t-1)				0.594***				
				(0.130)				
Chn. comp. -US -EU (t-1)					<0.001	<0.001	<0.001	<0.001
					(<0.001)	(<0.001)	(<0.001)	(<0.001)
Chn. comp. EU (t-1)					<0.001	<0.001	<0.001	<0.001
					(<0.001)	(<0.001)	(<0.001)	(<0.001)
interaction instrument 1						<0.001	<0.001	<0.001*
						(<0.001)	(<0.001)	(<0.001)
interaction instrument 2						<0.001***	<0.001	<0.001*
						(<0.001)	(<0.001)	(<0.001)
Observations	38774	38774	38774	38774	38774	38774	38774	38774
Sargan p-value	0.683	0.0154	0.368	0.453				
F-Statistic					522.0	466.0	464.1	277.5

Note: The "Int" terms are the interactions of the four China instruments with the interacted term from the corresponding column from table 5.8. In columns four and eight the instruments are lagged two instead of one period. Robust standard errors applied, stars denote significance at one (***), five (**) and ten (*) percent level of significance. A coefficient of < 0.001 represents coefficients that are too small for their first non-zero digit to appear numerically.

Table 5.10: Ln Export Sales - OLS

	Log export sales			
Chn. comp. US (t-1)	-0.498** (0.196)	-0.295 (0.225)	-2.718*** (0.231)	-3.033*** (0.702)
log Mex. imports (t-1)	0.0269** (0.0128)	0.0270** (0.0128)	0.0253** (0.0127)	0.0277** (0.0128)
log US. Imports (t-1)	0.00521 (0.0141)	0.00525 (0.0141)	0.000750 (0.0143)	0.00530 (0.0141)
log exp. sales (t-1)	0.423*** (0.0192)	0.423*** (0.0192)	0.418*** (0.0188)	0.404*** (0.0197)
Herf. (t-1)	-0.575** (0.261)	-0.401 (0.278)	-0.509** (0.252)	-0.580** (0.260)
log exp. share (t-1)	0.276*** (0.106)	0.273** (0.106)	-0.0607 (0.106)	0.268** (0.106)
skill share (t-1)	-0.136 (0.156)	-0.135 (0.156)	-0.117 (0.155)	-0.109 (0.157)
Chn. Herf int. (t-1)		-2.255* (1.238)		
Chn. exp share int. (t-1)			8.118*** (0.587)	
Chn. exp. sales int. (t-1)				0.260*** (0.0650)
Year f.e.	Yes	Yes	Yes	Yes
Plant f.e.	Yes	Yes	Yes	Yes
Observations	12139	12139	12139	12139

Note: Robust standard errors used, stars denote significance at one (***), five (**) and ten (*) percent level of significance.

Table 5.11: Ln Export Sales - IV

	Exp. sales	Exp. sales	Exp. sales	Exp. sales	ChnUS	ChnUS	ChnUS	ChnUS
Chn. comp. US (t-1)	-0.632 (0.491)	-0.561 (0.492)	-1.395*** (0.524)	-3.511*** (0.948)				
log US. Imports (t-1)	0.00615 (0.0134)	0.00613 (0.0134)	0.00390 (0.0133)	0.00674 (0.0134)	0.006*** (0.001)	0.006*** (0.001)	0.006*** (0.001)	0.006*** (0.001)
log Mex. imports (t-1)	0.0266** (0.0122)	0.0267** (0.0122)	0.0262** (0.0120)	0.0274** (0.0122)	-0.001** (0.0006)	-0.001** (0.0006)	-0.001** (0.0006)	-0.001** (0.0006)
log exp. sales (t-1)	0.423*** (0.0119)	0.423*** (0.0119)	0.421*** (0.0118)	0.403*** (0.0132)	j0.001 (j0.001)	j0.001 (j0.001)	j0.001 (j0.001)	j0.001 (j0.001)
Herf. (t-1)	-0.579** (0.278)	-0.522 (0.332)	-0.551** (0.274)	-0.585** (0.277)	-0.0384*** (0.0143)	0.0253 (0.0161)	-0.0385*** (0.0143)	-0.0379*** (0.0143)
log exp. share (t-1)	0.277*** (0.0886)	0.276*** (0.0886)	0.149 (0.0948)	0.269*** (0.0885)	0.00766* (0.00457)	0.00589 (0.00454)	0.00703 (0.00503)	0.00670 (0.00458)
skill share (t-1)	-0.135 (0.141)	-0.135 (0.141)	-0.128 (0.139)	-0.106 (0.141)	0.0107 (0.007)	0.00933 (0.00726)	0.0105 (0.00731)	0.0114 (0.00731)
Chn. Herf int. (t-1)		-0.734 (2.374)						
Chn. exp share int. (t-1)			3.078*** (0.886)					
Chn. exp. sales int. (t-1)				0.289*** (0.0805)				
Chn. comp. -US -EU (t-1)					-0.0362*** (0.0088)	-0.0413*** (0.0138)	-0.0444*** (0.0102)	-0.143*** (0.0278)
Chn. comp. EU (t-1)					0.776*** (0.019)	0.946*** (0.0264)	0.818*** (0.0253)	0.993*** (0.0695)
interaction instrument 1						-0.0282 (0.100)	0.0462* (0.0253)	0.0123*** (0.00300)
interaction instrument 2						-1.177*** (0.139)	-0.153*** (0.0573)	-0.0243*** (0.00721)
Observations	11771	11771	11771	11771	11771	11771	11771	11771
Sargan p-value	0.165	0.366	0.492	0.334				
F-Statistic					195.4	185.5	175.3	176.1

Note: Robust standard errors, controls for firm exit and firm exit from export used throughout. Stars denote significance at one (***), five (**) and ten (*) percent level of significance.

Table 5.12: Quantile regression - plant sales

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
log Chn. Imports (t-1)	-0.025*** (0.006)	-0.009** (0.003)	-0.006** (0.002)	-0.004* (0.002)	-0.003* (0.002)	-0.004* (0.002)	-0.003 (0.002)	-0.000 (0.003)	0.004 (0.004)
log tot. imports (t-1)	-0.029* (0.012)	-0.019** (0.007)	-0.011** (0.004)	-0.002 (0.003)	-0.002 (0.003)	0.001 (0.004)	0.005 (0.004)	0.011 (0.006)	0.012 (0.009)
log nr. Employment (t-1)	-0.039 (0.022)	-0.009 (0.011)	-0.003 (0.007)	-0.002 (0.005)	0.010* (0.005)	0.024*** (0.005)	0.040*** (0.006)	0.052*** (0.008)	0.088*** (0.015)
log sales (t-1)	0.749*** (0.020)	0.745*** (0.010)	0.748*** (0.005)	0.751*** (0.004)	0.743*** (0.004)	0.723*** (0.005)	0.704*** (0.005)	0.672*** (0.008)	0.612*** (0.015)
Herf. (t-1)	-0.971*** (0.242)	-0.441*** (0.127)	-0.370*** (0.074)	-0.330*** (0.059)	-0.303*** (0.056)	-0.241*** (0.064)	-0.286*** (0.069)	-0.296** (0.092)	-0.615*** (0.162)
exp. share (t-1)	0.030 (0.077)	0.020 (0.042)	0.025 (0.025)	0.056** (0.020)	0.037 (0.019)	0.056* (0.022)	0.053* (0.025)	0.072* (0.034)	0.116* (0.058)
skill share (t-1)	-0.282** (0.095)	-0.121* (0.051)	-0.044 (0.030)	-0.013 (0.024)	-0.004 (0.023)	0.008 (0.026)	0.014 (0.028)	0.022 (0.038)	0.046 (0.064)

Note: To mimic plant fixed effects all variables were demeaned. Stars denote significance at one (***), five (**)
and ten (*) percent level of significance. Q1 gives the quantile regression at the 10th percentile.

Table 5.13: Quantile IV regression - plant sales

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
log Chn. Imports (t-1)	-0.4199*** (0.0423)	-0.2522*** (0.0433)	-0.1959*** (0.0461)	-0.1635*** (0.0411)	-0.1106*** (0.0339)	-0.0591 (0.03)	-0.0336 (0.0362)	0.0246 (0.032)	0.1112*** (0.0284)
log tot. imports (t-1)	0.2127*** (0.0311)	0.1655*** (0.0366)	0.1323*** (0.0363)	0.1164*** (0.0331)	0.0812*** (0.0261)	0.0485** (0.0234)	0.0371 (0.0301)	-0.0027 (0.0241)	-0.0508*** (0.0208)
log nr. Employment (t-1)	0.03 (0.0251)	0.0514** (0.0208)	0.0448*** (0.0168)	0.0429** (0.0151)	0.0372*** (0.0129)	0.0401*** (0.011)	0.0554*** (0.0116)	0.0567*** (0.0135)	0.0757*** (0.0152)
log sales (t-1)	0.7523*** (0.0165)	0.7419*** (0.0136)	0.7517*** (0.0109)	0.7482*** (0.0104)	0.7503*** (0.0095)	0.7383*** (0.0086)	0.719*** (0.0081)	0.6841*** (0.0095)	0.6096*** (0.0105)
Herf. (t-1)	-1.5433*** (0.2107)	-0.9707*** (0.1664)	-0.6478*** (0.1353)	-0.5031*** (0.1167)	-0.3769*** (0.0871)	-0.3545*** (0.0917)	-0.2624*** (0.1028)	-0.2546*** (0.0941)	-0.4136*** (0.1352)
exp. share (t-1)	0.1338* (0.0732)	0.0739* (0.0498)	0.0657 (0.0411)	0.0613* (0.0393)	0.0625* (0.0331)	0.0688** (0.0289)	0.0564* (0.029)	0.0477 (0.03)	0.0608 (0.0447)
skill share (t-1)	-0.3725*** (0.0966)	-0.1942*** (0.0589)	-0.0838* (0.0466)	-0.0557 (0.0431)	-0.0102 (0.0377)	0.0076 (0.0335)	0.0201 (0.0351)	0.0468 (0.0416)	0.0145* (0.0499)

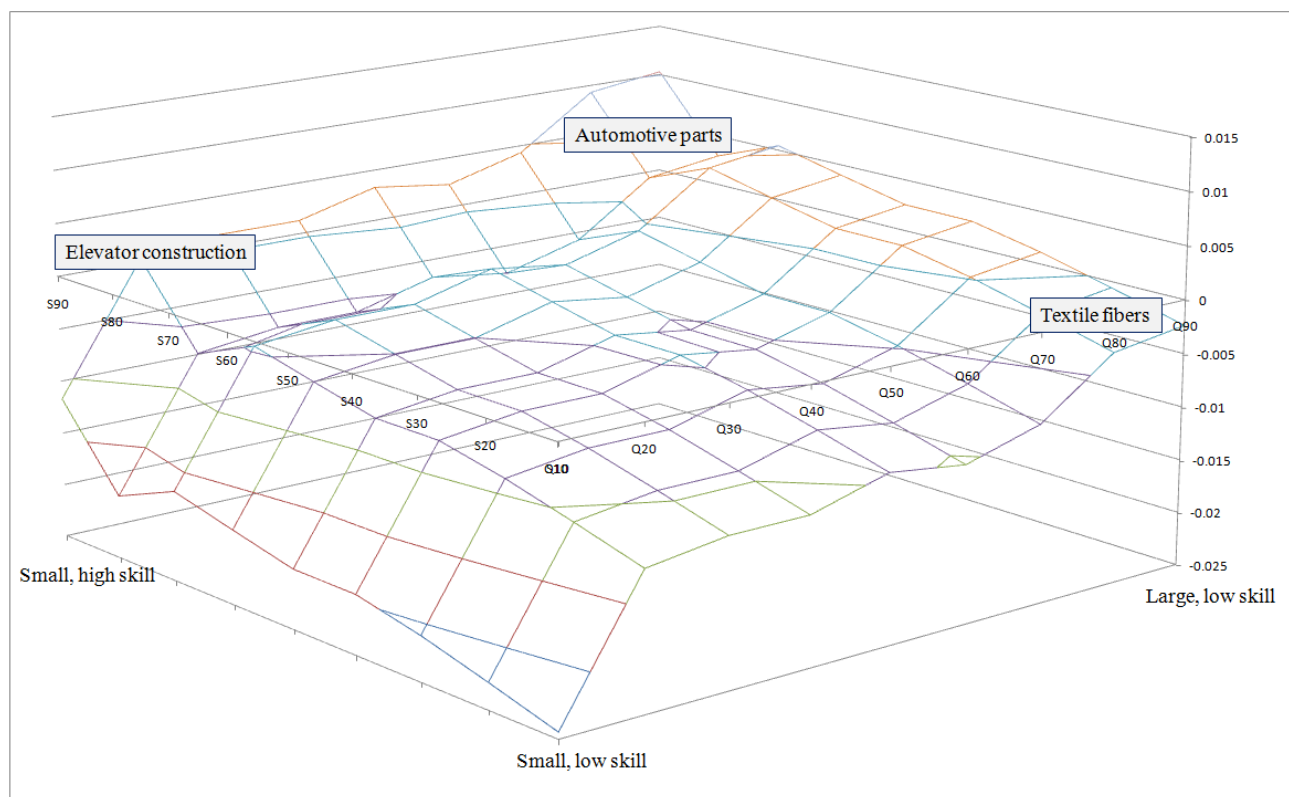
Note: To mimic plant fixed effects all variables were demeaned. The usual instruments were applied. Stars denote significance at one (***), five (**) and ten (*) percent level of significance. $Q1$ gives the quantile regression at the 10th percentile.

Table 5.14: Quantile - skill interaction, plant sales

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
lnLCHN_MEX	-0.024** (0.008)	-0.012** (0.005)	-0.011*** (0.003)	-0.011*** (0.002)	-0.009*** (0.002)	-0.010*** (0.002)	-0.008** (0.003)	-0.003 (0.004)	-0.002 (0.006)
lnLALL_MEX	-0.029** (0.012)	-0.020** (0.006)	-0.012** (0.004)	-0.004 (0.004)	-0.003 (0.003)	-0.001 (0.003)	0.003 (0.004)	0.010 (0.006)	0.009 (0.009)
LlnPO	-0.040 (0.022)	-0.009 (0.011)	-0.003 (0.006)	0.000 (0.005)	0.009* (0.005)	0.025*** (0.005)	0.038*** (0.006)	0.054*** (0.008)	0.091*** (0.014)
LlnVV	0.749*** (0.020)	0.744*** (0.009)	0.748*** (0.005)	0.750*** (0.004)	0.742*** (0.004)	0.723*** (0.004)	0.703*** (0.005)	0.671*** (0.008)	0.612*** (0.015)
LHerf6	-0.959*** (0.243)	-0.439*** (0.122)	-0.369*** (0.074)	-0.327*** (0.061)	-0.301*** (0.056)	-0.234*** (0.058)	-0.276*** (0.068)	-0.281** (0.094)	-0.611*** (0.152)
Lexpshare	0.031 (0.078)	0.024 (0.041)	0.029 (0.025)	0.053 (0.020)	0.046* (0.019)	0.055** (0.020)	0.055* (0.024)	0.070* (0.034)	0.117* (0.056)
Lskil	-0.271* (0.127)	-0.162* (0.068)	-0.136** (0.042)	-0.098** (0.036)	-0.075* (0.033)	-0.068 (0.035)	-0.086* (0.041)	-0.039 (0.055)	-0.038 (0.088)
i_CHNMEXsk 1	-0.004 (0.019)	0.010 (0.011)	0.017* (0.007)	0.020*** (0.006)	0.017* (0.005)	0.019*** (0.006)	0.020** (0.007)	0.011 (0.009)	0.021 (0.013)

Note: To mimic plant fixed effects all variables were demeaned. Stars denote significance at one (***), five (**) and ten (*) percent level of significance. Q1 gives the quantile regression at the 10th percentile.

Figure 5.2: Marginal effect of competition



This figure shows the marginal effect of competition as estimated in table 5.14. The axis from left to right displays initial size percentiles, the axis running back and forth skill share percentiles, and the vertical axis the effect of competition on size. For example: The front right corner shows a negative marginal effect of Chinese competition on size for the firm at the 5th percentile of size (Q5) and the 1 percent percentile of skillshare (S1).

Table 5.15: Product drop overall

	Product drop (OLS)		Product drop (IV)		First stage	
Chn. comp. Mex (t-1)	0.0879**	0.150**	0.330***	0.521***		
	(0.0399)	(0.0588)	(0.124)	(0.164)		
log imports (t-1)	0.000404	0.000406	0.000347	0.000356	<0.001	<0.001
	(0.00195)	(0.00196)	(0.00173)	(0.00174)	(<0.001)	(<0.001)
skill share (t-1)	-0.00554	-0.00558	-0.00421	-0.00437	-0.003*	-0.003*
	-0.0169	-0.0169	-0.0152	-0.0152	(0.00)	(0.00)
Herf. (t-1)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
log nr. prods. (t-1)	-0.0285***	-0.0289***	-0.0280***	-0.0293***	<0.001	<0.001
	(0.00613)	(0.00613)	(0.00549)	(0.00551)	(<0.001)	(<0.001)
log exp. share (t-1)	-0.0102	-0.0108	-0.00957	-0.0113	-0.003*	-0.003
	(0.0133)	(0.0133)	(0.0120)	(0.0122)	(0.00)	(0.00)
share (t-1)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
share interaction		-0.249*		-0.807***		
		(0.129)		(0.269)		
Chn. comp. -US -EU (t-1)					<0.001	<0.001
					(<0.001)	(<0.001)
Chn. comp. EU (t-1)					0.479***	0.520***
					(0.06)	(0.07)
interaction instrument 1						-0.192**
						(0.09)
interaction instrument 2						0.098***
						(0.004)
Observations	85770	85770	83276	83276		
Sargan p-value					0.2585	0.339
First stage F-value					16.89	15.27

Note: The "Int" terms are the interactions of the China instruments with the product share. Year and product fixed effects used throughout. Robust standard errors are clustered at CMAP 8 product level, stars denote significance at one (***), five (**) and ten (*) percent level of significance. A coefficient of < 0.001 represents coefficients that are too small for their first non-zero digit to appear numerically.

Table 5.16: Product drop from export

	Product drop (OLS)		Product drop (IV)		First stage	
Chn. comp. US (t-1)	-0.0542 (0.0567)	0.0695 (0.0821)	-0.0468 (0.0989)	0.161 (0.127)		
log imports (t-1)	-0.00338 (0.00464)	-0.00342 (0.00463)	-0.00338 (0.00405)	-0.00344 (0.00404)	<0.001 (<0.001)	<0.001 (<0.001)
skill share (t-1)	0.0143 (0.0397)	0.0163 (0.0398)	0.0145 (0.0346)	0.0177 (0.0347)	-0.016** (0.01)	-0.016** (0.01)
Herf. (t-1)	<0.001 (<0.001)	<0.001 (<0.001)	<0.001 (<0.001)	<0.001 (<0.001)	<0.001 (<0.001)	<0.001 (<0.001)
log nr. prods. (t-1)	0.0203* (0.0120)	0.0201* (0.0120)	0.0202* (0.0105)	0.0200* (0.0104)	0.003 (0.00)	0.003 (0.00)
log exp. share (t-1)	0.00235 (0.0164)	0.00298 (0.0164)	0.00231 (0.0143)	0.00348 (0.0143)	0.005* (0.00)	0.005* (0.00)
share (t-1)	-0.0582** (0.0247)	-0.0345 (0.0260)	-0.0582*** (0.0216)	-0.0164 (0.0239)	-0.004 (0.01)	0.003 (0.01)
share interaction		-0.375*** (0.114)		-0.661*** (0.172)		
Chn. comp. -US -EU (t-1)					0.285*** (0.04)	0.297*** (0.05)
Chn. comp. EU (t-1)					0.776*** (0.09)	0.838*** (0.10)
interaction instrument 1						-0.164 (0.17)
interaction instrument 2						-0.036 (0.07)
Observations	16687	16687	15837	15837		
Sargan p-value					0.24	0.25
First stage F-value					20.34	20.03

Note: The "Int" terms are the interactions of the China instruments with the product share. Product and year fixed effects as well as controls for firm exit and firm exit from export used throughout. Robust standard errors are clustered at CMAP 8 product level, stars denote significance at one (***), five (**) and ten (*) percent level of significance. A coefficient of < 0.001 represents coefficients that are too small for their first non-zero digit to appear numerically.

Table 5.17: Product sales

	Log sales - OLS		Log sales - IV		First stage	
Chn. comp. Mex (t-1)	-0.197 (0.185)	-0.868*** (0.262)	-1.245** (0.573)	-3.827*** (0.808)		
log imports (t-1)	0.0239** (0.0103)	0.0243** (0.0103)	0.0261** (0.0108)	0.0265** (0.0108)	0.001 (0.00)	0.001 (0.00)
skill share (t-1)	-0.286*** (0.0773)	-0.287*** (0.0768)	-0.239*** (0.0750)	-0.238*** (0.0751)	-0.005** (0.00)	-0.005** (0.00)
Herf. (t-1)	1.552** (0.631)	1.546** (0.630)	<0.001 (<0.001)	<0.001 (<0.001)	<0.001 (<0.001)	<0.001 (<0.001)
log nr. prods. (t-1)	-0.0132 (0.0247)	-0.00852 (0.0246)	0.0107 (0.0242)	0.0289 (0.0240)	-0.002* (0.00)	-0.002* (0.00)
log exp. share (t-1)	0.413*** (0.0550)	0.416*** (0.0550)	0.384*** (0.0545)	0.406*** (0.0548)	-0.002 (0.00)	-0.002 (0.00)
share (t-1)	<0.001 (<0.001)	<0.001 (<0.001)	<0.001 (<0.001)	<0.001 (<0.001)		
share interaction		1.894*** (0.425)		10.39*** (1.738)		
Chn. comp. -US -EU (t-1)					0.121*** (0.02)	0.120*** (0.02)
Chn. comp. EU (t-1)					0.517*** (0.07)	0.540*** (0.07)
interaction instrument 1						-0.083 (0.07)
interaction instrument 2						0.000 (0.00)
Observations	107601	107601	91517	91517		
R-squared	0.925	0.925	0.095	0.088		
Number of product			14346	14346		
Sargan p-value					0.8090	0.73
First stage F-value					18.93	18.78

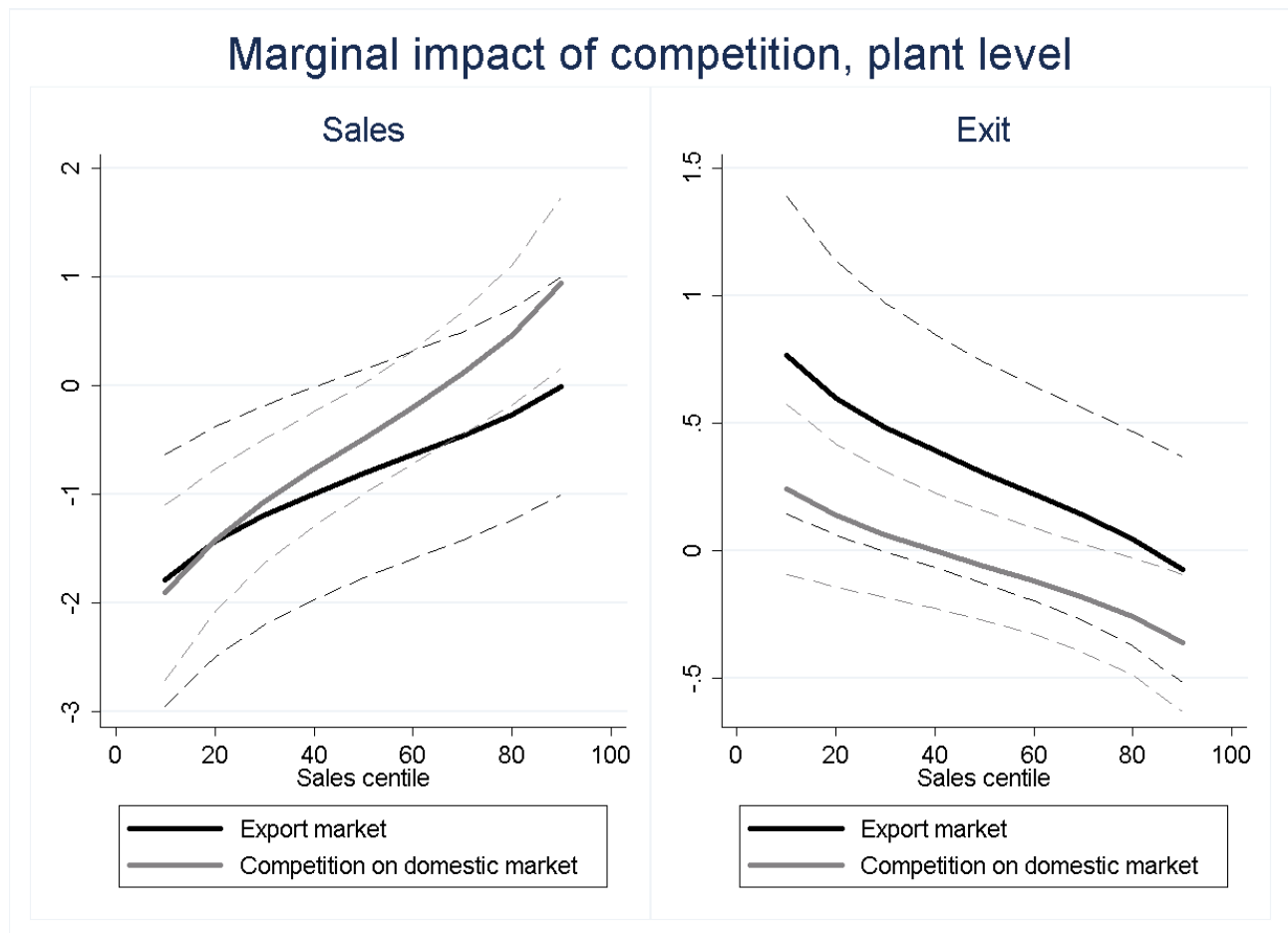
Note: The "Int" terms are the interactions of the China instruments with the product share. Year and product fixed effects used throughout. Robust standard errors are clustered at CMAP 8 product level, stars denote significance at one (***), five (**) and ten (*) percent level of significance.

Table 5.18: Export sales product

	Log exp. sales - OLS		Log exp. sales - IV		First stage	
Chn. comp. US (t-1)	-0.794** (0.319)	-1.876*** (0.368)	-1.014* (0.567)	-2.396*** (0.585)		
log imports (t-1)	0.129*** (0.0461)	0.129*** (0.0461)	0.129*** (0.0403)	0.129*** (0.0403)	0.001 (0.00)	<0.001 (<0.001)
skill share (t-1)	-0.140 (0.217)	-0.160 (0.217)	-0.146 (0.190)	-0.172 (0.190)	-0.007 (0.01)	-0.011 (0.01)
Herf. (t-1)	0.373 (0.903)	0.350 (0.903)	<0.001 (<0.001)	<0.001 (<0.001)	-0.000*** (0.00)	-0.000*** (0.00)
log nr. prods. (t-1)	-0.000195 (0.0119)	0.00264 (0.0117)	-0.000331 (0.0104)	0.00299 (0.0103)	-0.000 (0.00)	-0.000 (0.00)
log exp. share (t-1)	1.436*** (0.0913)	1.424*** (0.0908)	1.437*** (0.0800)	1.423*** (0.0794)	0.003 (0.00)	0.003 (0.00)
share (t-1)	1.85e-05 (1.68e-05)	1.54e-05 (1.54e-05)	1.80e-05 (1.47e-05)	1.41e-05 (1.33e-05)	0.000 (0.00)	-0.000*** (0.00)
share interaction		3.421*** (0.660)		4.076*** (0.854)		
Chn. comp. -US -EU (t-1)					0.302*** (0.04)	<0.001 (<0.001)
Chn. comp. EU (t-1)					0.824*** (0.09)	1.019*** (0.11)
interaction instrument 1						-0.184 (0.15)
interaction instrument 2						<0.001 (<0.001)
Observations	21049	21049	19802	19802	19802	19802
Sargan p-value					0.33	0.46
First stage F-value					29.18	24.64

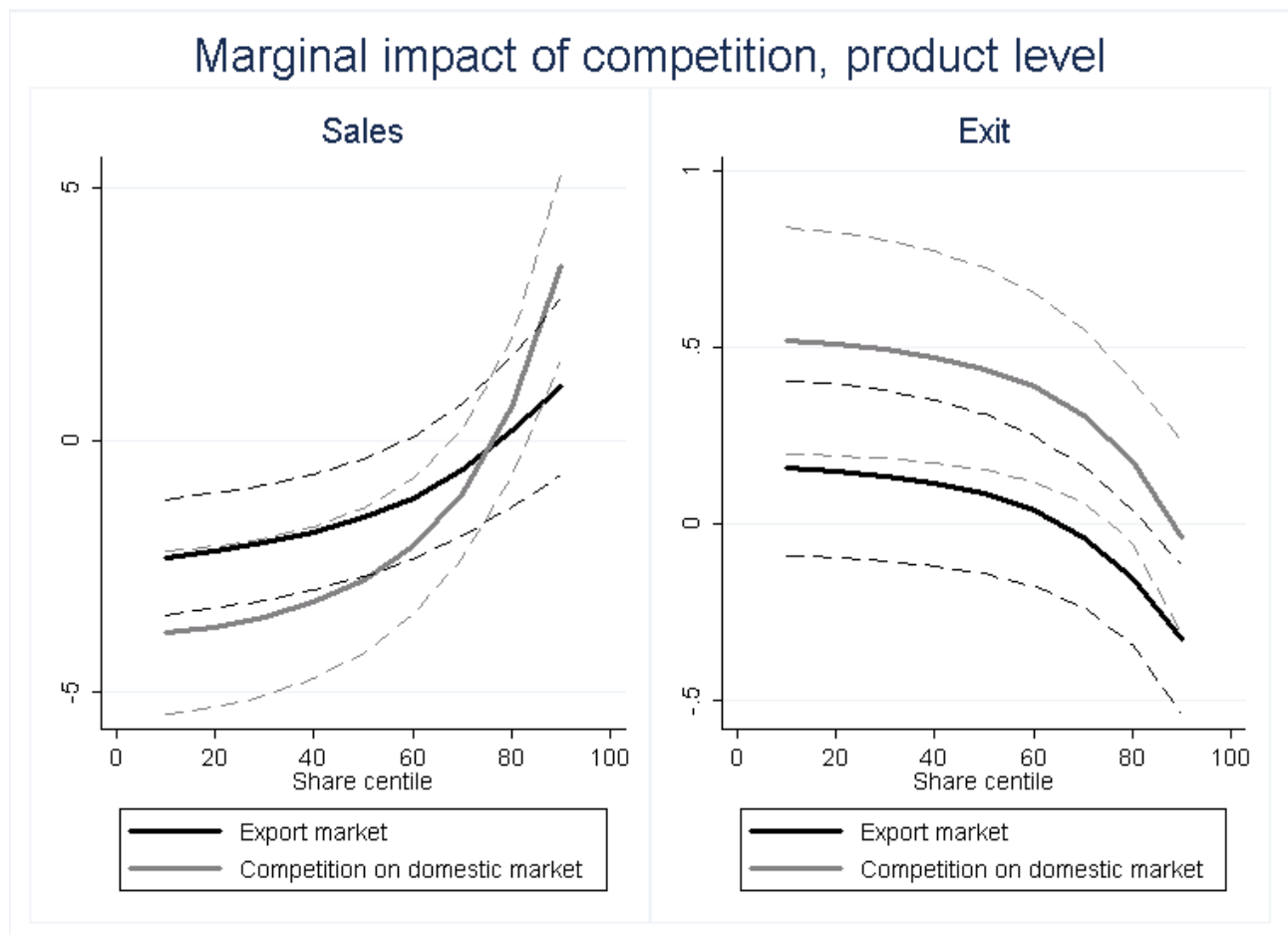
Note: The "Int" terms are the interactions of the China instruments with the product share. Robust standard errors are clustered at CMAP 8 product level, stars denote significance at one (***), five (**) and ten (*) percent level of significance. A coefficient of < 0.001 represents coefficients that are too small for their first non-zero digit to appear numerically. Year and product fixed effects as well as controls for firm exit and firm exit from export used throughout.

Figure 5.3: Marginal effect of competition, plant level



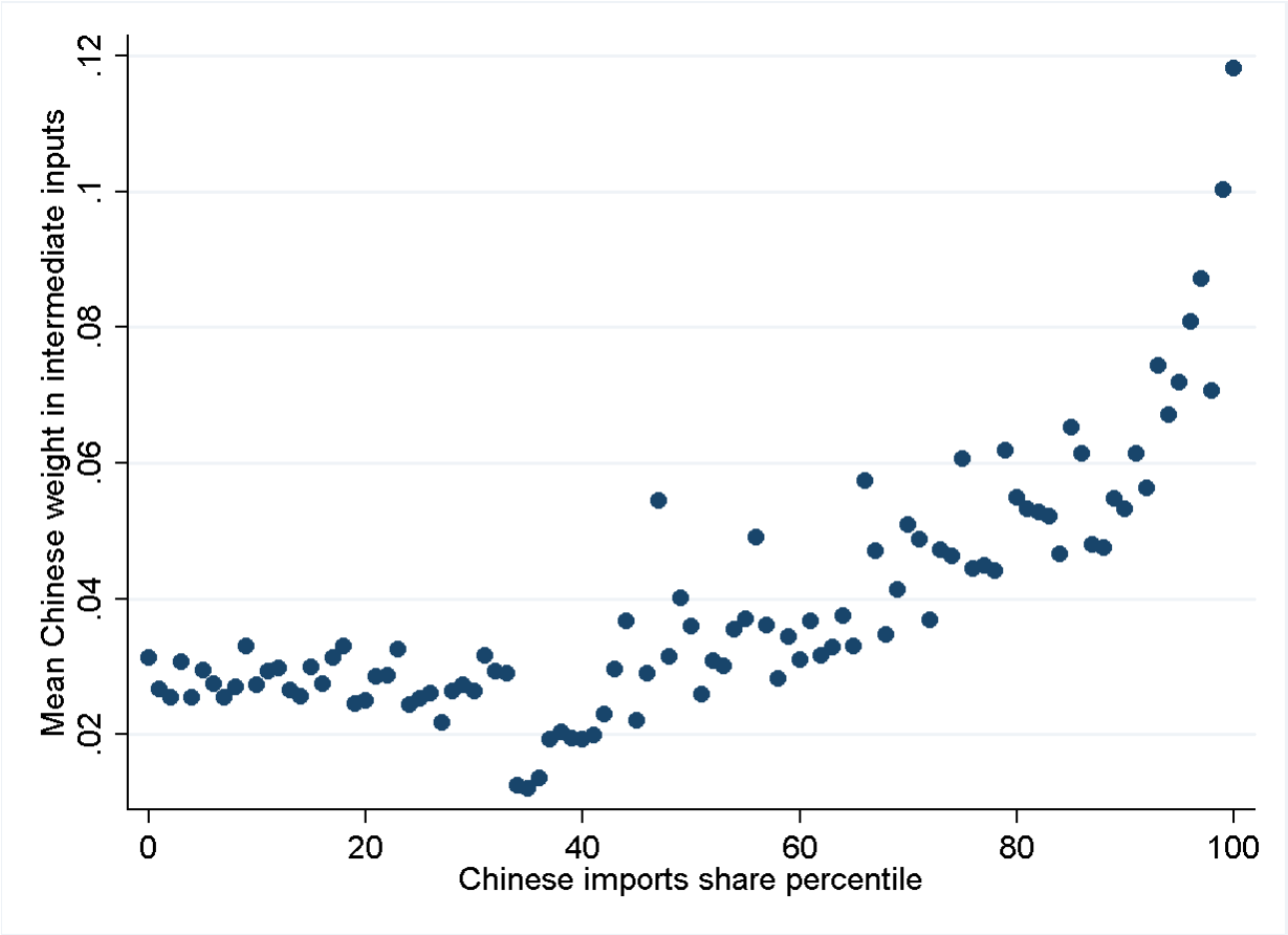
Based on the fourth column of the OLS regressions reported in tables 5.5, 5.7, 5.9 and 5.11.

Figure 5.4: Marginal effect of competition, product level



Based on the fourth column of the OLS regressions reported in tables 5.15, 5.16, 5.17 and 5.18.

Figure 5.5: Chinese importance in inputs



This graph shows the relationship of Chinese imports share in inputs and overall.

Table 5.19: Chinese impact via intermediate inputs

	Exit	Exit Exp.	Sales	Exp sales
Chn. comp. Mex (t-1)	0.599* (0.327)		-0.125 (0.690)	
Sales interaction (t-1)	-0.0550** (0.0279)		0.0209 (0.0602)	
Chn. comp. US (t-1)		0.693*** (0.219)		-2.992*** (1.021)
Sales interaction (t-1)		-0.0696*** (0.0201)		0.219*** (0.0848)
Chn. imp. share (t-1)	1.361*** (0.371)	4.904*** (0.891)	-4.985*** (0.743)	-13.14*** (1.640)
Sales interaction (t-1)	-0.109*** (0.0323)	-0.381*** (0.0703)	0.412*** (0.0655)	1.086*** (0.133)
Observations	35828	11414	39254	12139

Note: These regressions are identical to the fourth column of plant OLS regressions in tables 5.4, 5.6, 5.8 and 5.10, except that "inputs share" and "inputs share int." are also included. Only the main coefficients are reported. Robust standard errors are applied, stars denote significance at one (***), five (**) and ten (*) percent level of significance. The interactions report the coefficient on the product of sales with the previous variable.

Table 5.20: Robustness 1

	Top 20% competition				Bottom 20% competition			
	Exit	Exit exp.	Dom. sales	Exp. sales	Exit	Exit exp.	Dom. sales	Exp. sales
Chn. comp. Mex. (t-1)	0.884*** (0.319)		-1.285* (0.736)		11821 (8723)		2665 (13635)	
Sales interaction (t-1)	-0.0751*** (0.0270)		0.129** (0.0638)		-971.0 (699.0)		-268.4 (1417)	
Chn. comp. US.		0.610* (0.350)		-4.364*** (1.192)		-0.267 (1.048)		-5.311 (5.771)
Sales interaction (t-1)		-0.0500* (0.0286)		0.356*** (0.100)		-0.00466 (0.0870)		0.466 (0.432)
Observations	7843	5026	7856	5423	4697	1601	4941	1534
R-squared	0.374	0.439	0.936	0.907	0.475	0.462	0.929	0.911

Note: These regressions are identical to the fourth column of plant OLS regressions in tables 5.4, 5.6, 5.8 and 5.10, except that they report the subsamples of the 20 percent top and bottom mean competition. Only the main coefficients are reported. Robust standard errors are applied, stars denote significance at one (***), five (**) and ten (*) percent level of significance.

Table 5.21: Robustness 2

	Placebo			No antidumping			
	Dom. sales	Exp. sales		Exit	Exit exp.	Dom. sales	Exp. sales
Chn. comp. Mex. (t+4)	-1.491 (1.882)		Chn. comp. Mex. (t-1)	0.676* (0.380)		-2.179*** (0.823)	
Sales interaction (t+4)	0.139 (0.176)		Sales interaction (t-1)	-0.0600* (0.0324)		0.206*** (0.0711)	
Chn. comp. US. (t+4)		-1.480 (2.731)	Chn. comp. US. (t-1)		1.374*** (0.387)		-5.504*** (1.288)
Sales interaction (t+4)		0.280 (0.249)	Sales interaction (t-1)		-0.106*** (0.0311)		0.409*** (0.107)
Observations	12970	3597	Observations	30400	9491	33327	10110
R-squared	0.962	0.956	R-squared	0.422	0.451	0.948	0.905

Note: These regressions are identical to the fourth column of plant OLS regressions in tables 5.4, 5.6, 5.8 and 5.10, except for the following modifications: In the first two regressions we report the regression for the years 1994-1998 with forward looking competition (for exit the forward competition can't be determined). The last four regressions show the results for the subsample of plants in sectors not affected by successful Mexican anti-dumping cases with respect to China.

Table 5.22: Robustness 3, Industry-year fixed effects

	(1) Exit	(2) Exit_Exp	(3) Sales	(4) Exp. sales
Comp. Mex. (t-1)	0.758** (0.323)		-1.024 (0.737)	
Comp. interaction Mex	-0.0676** (0.0274)		0.106* (0.0638)	
Comp. US. (t-1)		0.894** (0.349)		-4.575*** (1.197)
Comp. interaction US		-0.0756*** (0.0281)		0.344*** (0.0986)
Constant	0.709*** (0.0510)	0.345*** (0.103)	3.955*** (0.184)	5.207*** (0.311)
Observations	35828	9993	34483	10663
R-squared	0.427	0.477	0.947	0.908

Note: These regressions are identical to the fourth column of plant OLS regressions in tables 5.4, 5.6, 5.8 and 5.10, except for the additional inclusion of HS-2-year control variables. An example of such a control would be fertilizers in the year 2000.

Table 5.23: Product - cmap 8 instead of firm-product fixed effects

	Product drop	Product drop	Sales	Sales
China comp.	0.0468 (0.0367)	0.157*** (0.0439)	-0.371** (0.171)	-3.432*** (0.210)
Tot. imp. (t-1)	-0.00172 (0.00170)	-0.00171 (0.00170)	0.0353*** (0.00963)	0.0371*** (0.00962)
Skill (t-1)	-0.00786 (0.00616)	-0.00793 (0.00616)	0.529*** (0.0363)	0.522*** (0.0362)
Herf (t-1)	<0.001 (<0.001)	<0.001 (<0.001)	1.578*** (0.338)	1.537*** (0.337)
Nr. prod (t-1)	-0.0119*** (0.00236)	-0.0132*** (0.00237)	-0.588*** (0.0113)	-0.540*** (0.0114)
Exp. share (t-1)	-0.0292*** (0.00806)	-0.0301*** (0.00807)	1.747*** (0.0537)	1.766*** (0.0540)
Prod. share (t-1)	1.14e-06 (2.23e-05)	2.19e-06 (2.15e-05)	0.000311 (0.000784)	0.000279 (0.000753)
Share int. (t-1)		-0.448*** (0.0899)		9.073*** (0.387)
Observations	85770	85770	107601	107601
Year f.e.	Yes	Yes	Yes	Yes
Cmap 8 f.e.	Yes	Yes	Yes	Yes

Table 5.24: Quantile product regression

	Q_10	Q_20	Q_30	Q_40	Q_50	Q_60	Q_70	Q_80	Q_90
Chn comp. (t-1)	-0.426*	-0.257*	-0.045	0.076	0.092	0.136*	0.147*	0.131	0.354**
	(0.197)	(0.103)	(0.069)	(0.06)	(0.058)	(0.06)	(0.066)	(0.087)	(0.137)
Log tot. imp. (t-1)	0.009	0.031***	0.034***	0.035***	0.038***	0.043***	0.046***	0.051***	0.054***
	(0.01)	(0.005)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)	(0.007)
Skill (t-1)	-0.309**	-0.286***	-0.249***	-0.207***	-0.197***	-0.181***	-0.152***	-0.167***	-0.166**
	(0.105)	(0.051)	(0.034)	(0.029)	(0.027)	(0.028)	(0.031)	(0.041)	(0.064)
Herf (t-1)	1.111*	1.707***	2.100***	2.509***	2.880***	2.965***	2.809***	2.414***	2.475***
	(0.521)	(0.254)	(0.163)	(0.137)	(0.127)	(0.133)	(0.152)	(0.209)	(0.314)
Nr prod (t-1)	-0.012	-0.018	-0.029*	-0.037***	-0.039***	-0.038***	-0.047***	-0.040**	-0.007
	(0.034)	(0.017)	(0.011)	(0.01)	(0.009)	(0.01)	(0.011)	(0.015)	(0.024)
Exp. share (t-1)	0.421***	0.369***	0.356***	0.362***	0.361***	0.367***	0.383***	0.381***	0.364***
	(0.082)	(0.038)	(0.024)	(0.021)	(0.02)	(0.021)	(0.023)	(0.033)	(0.057)
Prod. share (t-1)	<0.001***	<0.001*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001*
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)

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Chapter 6

Deutschsprachige Zusammenfassung

Diese Doktorarbeit präsentiert verschiedene Forschungsergebnisse die ich während meiner letzten Jahre im Initiativkolleg Volkswirtschaft der Universität Wien, als Forschungsassistent an der London School of Economics und als Konsulent bei der Weltbank in Washington erziehen konnte. Alle vorgestellten Kapitel betrachten verschiedene empirische und theoretische Situationen in denen Firmen strategischen Entscheidungen unter Wettbewerb ausgesetzt sind. Zusammen zeigen die einzelnen Kapitel mehrere Probleme für Firmen in einer globalisierten Welt, beispielsweise die Überlebenswahrscheinlichkeit Afrikanischer Exporteure, den Druck durch Wettbewerb aus China, Investitionen in Forschung und Werbung.

Das erste Kapitel betrachtet Firmenverhalten in Bezug auf Werbung. Ich betrachte eine Änderung der Werbesteuer in Österreich in 2000 als ein natürliches Experiment, mit dessen Hilfe ich schätzen kann, wie Preise und Werbeausgaben auf eine Erhöhung der Werbekosten reagieren. Ich zeige, dass Information und Überzeugung in der Werbung vorhanden sind. Informative Werbung erhöht den Wettbewerb und senkt die Marktpreise, Überzeugung verschiebt die Nachfragekurve nach außen und erhöht die Preise. Beide Effekte sind in den Daten vorhanden; in manchen Industrien dominiert Information, und in anderen Überzeugung.

Ein zweiter Artikel präsentiert ein einfaches Modell von Wettbewerb und Werbung, welches ebenfalls als ein Modell von Wettbewerb und Forschung interpretiert werden kann. Es basiert auf einem Dixit-Stiglitz Modell, und kann zeigen, wieso die Beziehung zwischen Wettbewerb und Forschung eine invertierte U Form aufweist. Bei niedrigen Wettbewerbsniveaus ist es nicht leicht zusätzliche Konsumenten mit Forschung zu gewinnen, da man seinen Rivalen keine Konsumenten streitig machen kann; bei hohen Niveaus sind die Preisaufschläge so gering, dass Innovation keine zusätzlichen Profite generiert. Das Modell impliziert ein invertiertes U auf Firmen und Industrielevel. Das Modell ist konsistent mit empirischen Beobachtungen der letzten Jahre.

Ein dritter Artikel betrachtet Afrikanische Exporter, und analysiert welche von ihnen länger überleben. Diese Arbeit basiert auf einem neuen Datensatz, das detaillierte Informationen über Afrikanische Exporter beinhaltet. Afrikanische Firmen bleiben im internationalen Vergleich nur sehr kurze Zeiträume auf Exportmärkten bestehen. Wir zeigen, dass Erfahrung mit Märkten und Produkten, sowie dass Netzwerke (wenn mehrere Firmen aus dem gleichen Land das gleiche Produkt in ein anderes gleiches Land exportieren) die Exportströme stark verlängern.

Das letzte Kapitel dieser Dissertation untersucht, wie Mexikanische Firmen auf den erhöhten Wettbewerbsdruck von China reagieren. Wir finden starke, heterogene Effekte. Größere Firmen sind deutlich weniger getroffen als kleinere, deren Verkäufe massive einbrechen, sodass viele von ihnen den Markt

verlassen. Diese empirischen Beobachtungen treffen in gleicher Weise für Mexikanische Exporteure zu, die auf Exportmärkten auf Chinesischen Wettbewerb treffen. Diese Arbeit belegt einige Thesen der theoretischen Literatur zu Firmen mit mehreren Produkten der letzten Jahre. Zusätzlich wurden die Ergebnisse bei den Empfehlungen der Weltbank an Entwicklungsländer im Umgang mit China eingebaut.

Chapter 7

CV

CURRENT POSITIONS

- Research Officer (Post Doc) at the London School of Economics, beginning summer 2010
- Consultant at the World Bank (Development Economics Research Group), since March 2009
- PhD student in economics, University of Vienna, since October 2007
- Researcher assistant at the Center of Economic Performance at the London School of Economics, since June 2007

PREVIOUS EDUCATION

- 2006 - 2007 London School of Economics
MSc Economics (Research)
- 2003-2006 Universitt Wien (University of Vienna)
Masters degree in Economics
- Spring 2005 Universidad de Salamanca (University of Salamanca)
Foreign semester with ERASMUS.

PUBLISHED BOOKS

“Innovation in Modellen der endogenen Wachstumstheorie”, VDM Publishing Saarbrcken, ISBN: 978369222623, December 2009

WORKING PAPERS AND WORK IN PROGRESS

- “Advertising expenditures and consumer prices”, work in progress
- “Competition and Innovation of Mexican firms”, work in progress, joint with Leonardo Iacovone and Wolfgang Keller

- “Success and failure of African businesses on export markets”, work in progress, joint with Olivier Cadot, Leonardo Iacovone and Martha Denisse Pierola
- “Trade as Engine of Creative Destruction - The Mexican experience with Chinese competition”, Mimeo, joint with Leonardo Iacovone and L. Alan Winters
- “Urbanization and Spatial Agglomeration”, CEPR Discussion Paper 7016, joint with Stephen Redding and Guy Michaels, 2009
- “An explanation for the inverted-U relationship between competition and innovation”, draft, University of Vienna
- “Human capital as explanation of wealth differences within Europe”, MSc thesis submitted at the London School of Economics, supervisor: Oriana Bandiera, 2007
- “Horizontale und vertikale Innovation in Modellen der endogenen Wachstumstheorie”, Magister Thesis submitted at the University of Vienna, supervisor: Gerhard Sorger, 2006

PRESENTATIONS AT SCIENTIFIC CONFERENCES AND SEMINARS

- 2010: The World Bank Africa Section, Washington DC (January); London School of Economics, CEP conference (May); QED conference, Alicante (May);
- 2009: Midwest Economic Meetings, Penn State University (October), United States International Trade Commission (USITC), Washington DC (October); University of Vienna staff seminar, (October); European Trade Study Group conference (ETSG), Rome (September); First IK workshop, University of Vienna (September); The World Bank Trade Seminars, Washington DC, (November);
- 2008: University of Vienna graduate and staff seminar (June); Pro Scientia Austria, Vienna (November)

TEACHING EXPERIENCE

- Winter term 2009/10: “Mathematics - high school revision” (undergraduate level)
- Winter term 2008/09: “Mathematics - high school revision” (undergraduate level)
- Summer term 2007/08: “Industrial organisation” (graduate level)

PREVIOUS EMPLOYMENT

- 2005 - 2006 Research Assistant to Prof. John Naisbitt
- Summer 2005 Austrian Ministry of Economics (Summer intern)

- Summer 2004 Austrian Chamber of Commerce Shanghai (Summer intern)
- Summer 2003 Newspaper “Die Presse” (Free-lance journalist)
- 2002-2003 Austrian Military
Obligatory military service fulfilled
- 1999-2001 School representative - Gymnasium and State Student Representative Board